POWER

Volume 66 New York, August 23, 1927 Number 8

Gumption

I DO not know who bestowed this grotesque name upon this quality or combination of qualities that deserves the best name that philologists could coin.

Gumption, the quality that makes the difference between the man who does things—gets them done, stands over them a victor and enjoys the fruit of their accomplishment—and the man who stands inanely around wondering how they ought to be started.

Gumption is not a simple quality. It is a compound of a lot of characteristics and abilities that need to be cultivated each by itself and taught to work in unison, like the well-timed components of a golfer's stroke.

In the first place there must be the will to do. Anybody but a damphool can do anything that is reasonably within human capabilities if he wants to badly enough.

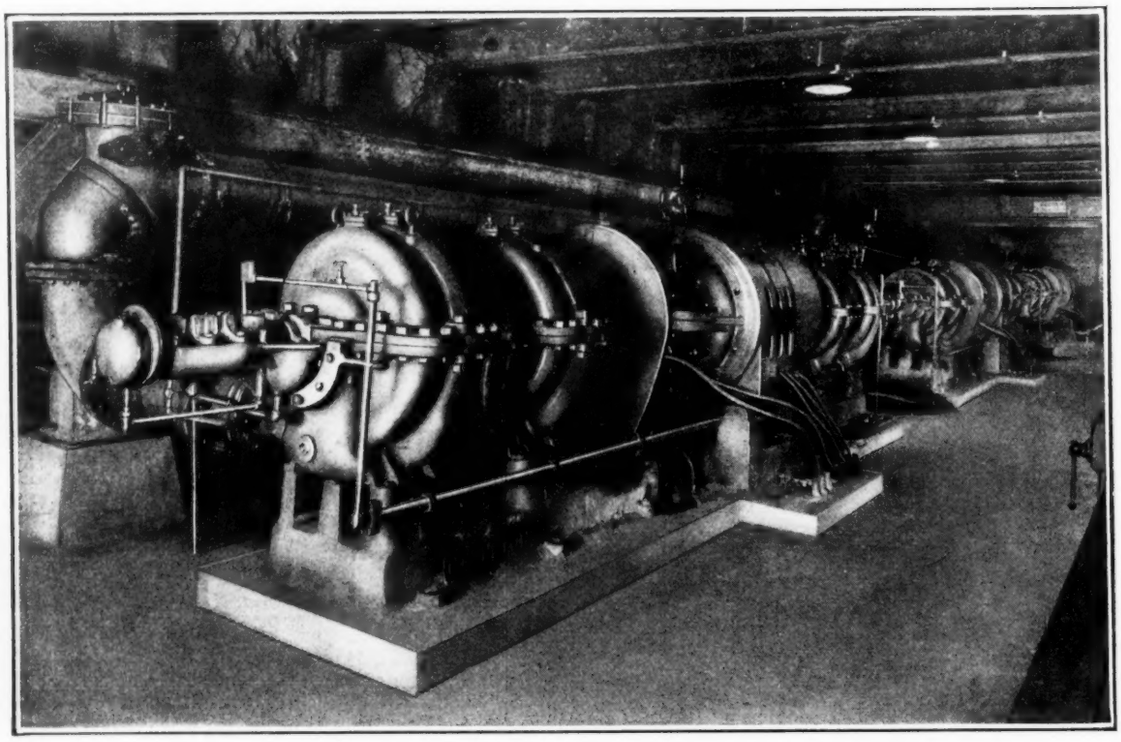
Then gumption involves judgment as to ways and means; how best to approach the task; just the good old every-day common sense.

And then there must be a certain amount of manual skill if the task is a physical one, of executive ability if it is one of management.

The correspondent who complains in a recent issue that it takes two years of training to make a worth-while engineer out of a technical graduate evidently takes the technical school course for an apprenticeship in applied mechanics.

If it can cultivate the qualities that go to make up gumption, teach men to use their brains and co-ordinate them with a will to do, the technical school will render an invaluable service in fostering a quality that is becoming increasingly difficult to find in these days of ringing for the janitor instead of doing it yourself.

F. R. Low



Three large centrifugal pumps that are started automatically

Automatic Starting of Centrifugal Pumps

By C. N. McDavitt,
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A System for the Automatic Priming and Starting of Centrifugal Pumps That Allows Them To Be Operated Safely Without an Attendant, when Located Above the Intake Water Level

WATER in varying quantities is to be expected in all mines. The handling of this water presents a number of interesting problems. Anthracite mines in Pennsylvania in all probability present the worst condition in this respect. The average weight of water pumped is approximately 20 tons per ton of coal from an average depth of approximately 500 ft. While these figures indicate the average, the majority of these mines must have large surplus pumping capacity as, during flood times the volume of water reaches 100 tons per ton of coal mined.

Metal mines have the same problems, although to a somewhat less degree. It is obvious, then, that the investment in pumping equipment is large and the problems attending pumping are important. Mine pumps operate intermittently over long periods of time and, therefore, require either personal attendance or an automatic system which is able to duplicate manual operation.

Centrifugal pumps are considered by mine engineers to be the logical pumping unit, as they require less space and have a lower initial and operating cost than plunger pumps. Their automatic operation has been developed to a point where little attendant labor is required except for periodic inspection of mechanical parts. This discussion will deal with centrifugal pumps only; there is no difficult problem in the automatic starting and stopping of plunger-type pumps, as they are self priming.

Where conditions are such that the intake water level is above the pump, automatic operation of centrifugal pumps has been common practice for a long time. In high city buildings where the water is pumped to a roof tank, centrifugal pumps are generally used. In this case the pressure of the street main is sufficient to insure that the pump will be primed. Where vertical-shaft centrif-

ugal pumps are used, they are placed below the surface of the water and are therefore always primed. In some cases horizontal-shaft centrifugal pumps are placed in concrete-lined pits at a level where their center line is below the level of the water in the intake, thus insuring the pump being primed. Under these conditions automatic operation of centrifugal pumps involves only a control for starting and stopping the motor from a float switch or other device.

When pumps are installed above the water level, means must be provided to insure that they will be primed

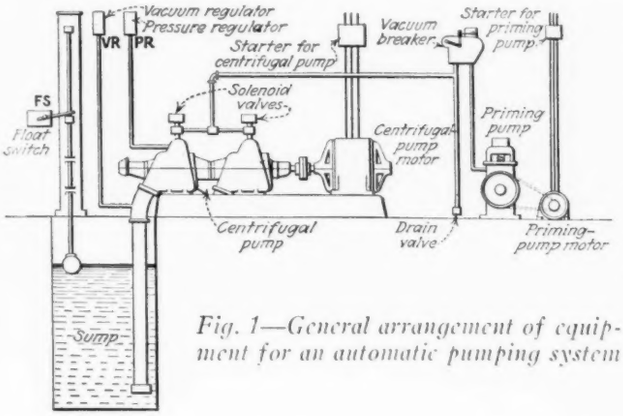


Fig. 1—General arrangement of equipment for an automatic pumping system

before they are started. In some cases check or float valves have been used to retain the water in the pump after it has once been primed. However, these valves are rather uncertain in their operation, particularly if the water is dirty. The valves may be in good operating condition, but dirt or other objects may lodge on their seats and prevent their closing tightly. In such cases, when the pump is shut down, the water will leak from the pump back into the intake and when the pump is again started it will not be primed. Installations of this kind require an attendant to be present when the pump is started, to see that it is primed. To make such pumps fully automatic in their starting, systems have been developed for automatically priming the pump before it can be started and performing other functions that are normally done by an attendant.

Factors in Automatic Operation

Automatic operation of centrifugal pumps was first developed in the anthracite fields, and since that time rapid progress has been made. The main points that must be met in automatic operation are:

1. Priming the pump when the water in the sump reaches a predetermined high level.
2. Protection against starting the pump unless fully primed.
3. Starting the pump when fully primed.
4. Stopping the priming pump when the pump starts.
5. Allowing the pump to run, dependent upon its protective devices.
6. Stopping the pump when the water in the sump reaches a predetermined low level.
7. Stopping the pump if the discharge pressure is lost or if the suction column breaks.

Fig. 1 shows a typical automatic pumping layout. The double-pole float switch *FS* is for starting and stopping the equipment as in any pump installation. Connected into the suction line is a vacuum regulator *VR* which has a pressure element and switch. The pressure element is adjusted so that between certain limits of vacuum the switch remains closed. If for any reason the vacuum is broken in the suction line, in which case the pump would be operating without water, the vacuum regulator switch will open and stop the pump's motor.

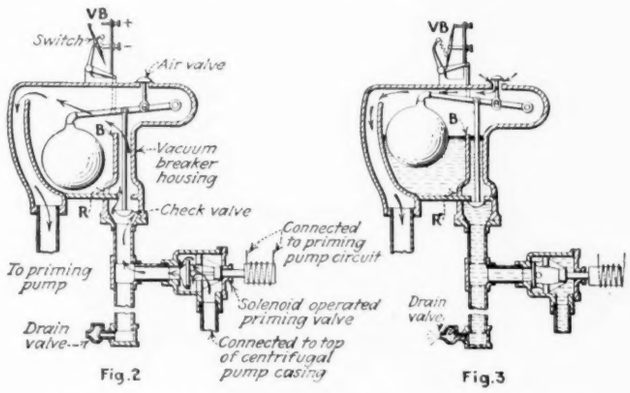
At the top of the pump casing is connected a pressure regulator *PR*, which has a pressure element acting upon a switch in the control circuit. Until the pressure builds up in the casing to a safe value, this switch remains open. When the pump is properly primed, the pressure on the regulator will close the switch and the pump will continue in operation. If for any reason, after the pump has gone into operation, the pressure in its casing falls below a given value, the pressure regulator switch will open and shut down the equipment.

On top of the casings are two solenoid-operated valves. These solenoids are energized from the priming pump motor's line contactors. They hold the valves open to allow air and water to be drawn by the priming pump, from the casing during the priming operation. A vacuum breaker is located between the solenoid-operated priming valves and the priming pump. The function of this breaker will be made clear in the explanation of the operation of the priming pumps.

Priming the Pump

The first operation is to start the priming pump, Fig. 1. This is a so-called dry pump in that it draws air out of the centrifugal pump casing through the vacuum breaker. As air is removed from the pump casing, water rises from the sump into the casing and then into the vacuum breaker. The pump casing, then being free of air, is primed, and the centrifugal pump may be started.

Fig. 2 shows the vacuum breaker and one of the solenoid-operated priming valves. In the position shown, the priming valve is held open by the solenoid, which is energized when the priming-pump line contactor closes, as previously explained. With the priming pump running, air is drawn through the vacuum breaker as indicated by the arrows. At the beginning of this period the vacuum-breaker float is in its lowest position; the check valve attached to the float rod is open; the drain



Figs. 2 and 3—Show vacuum-breaker before and after the pump is primed

valve is closed; the vacuum breaker switch is open, and the air valve connected to the float is closed.

As the air is drawn out of the pump casing, water gradually comes up into the float chamber. The water as it comes into the float chamber is turbulent, which causes a jerky operation of the float and in turn would cause the double-pole vacuum-breaker switch to have the same action. If the vacuum-breaker switch were to

make and break its contact as the water rises in the vacuum breaker, the priming pump would be thrown on and off the line. To remedy this difficulty, a baffle *B* is placed in the vacuum breaker, over which the water flows into the float chamber, the air going directly to the priming pump. A certain force is required to break the seal of the air valve. As water rises in the float chamber, the float becomes submerged until a lifting force is developed, sufficient to raise the air valve from its seat.

The air valve being relieved of the downward force of atmospheric pressure to hold it on its seat, the float jumps to its upper position. In doing this it closes the switch *VB* in the centrifugal-pump motor's control circuit and this motor is started and the priming pump shut down. The float also closes the check valve and completes opening the air valve. The latter operation allows air to enter the float chamber and breaks the vacuum.

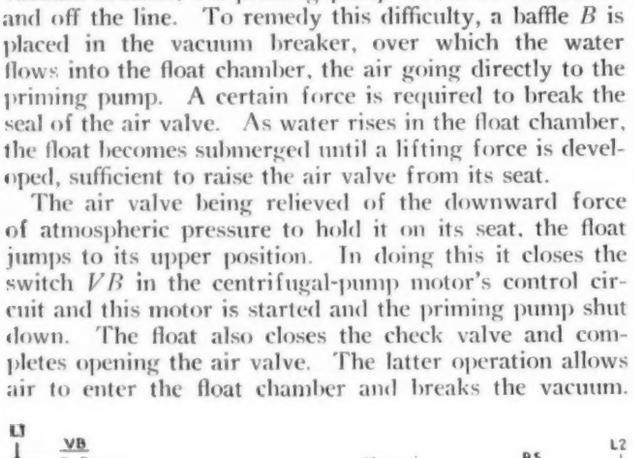


Fig. 4—Simplified diagram of pump-motor control circuits

The check valve is so designed that when the vacuum is broken, the water leaks slowly out of the float chamber. This draining of the vacuum-breaker chamber is through port *R* and is slow enough to allow the centrifugal pump to develop sufficient pressure in its casing to close the contacts of the pressure-regulator switch *PR*, before the float in the vacuum breaker drops to a position where switch *VB* opens. The vacuum-breaker switch *VB* is shunted by the pressure-regulator switch, therefore unless the pressure-regulator switch closes before the vacuum-breaker switch opens, the starting operation cannot be completed, as will be shown later.

Control Circuits Analyzed

In Fig. 3 priming has been completed and water has been drawn from the pump casing into the vacuum-breaker float chamber. In this position the vacuum-breaker switch is closed, the air valve is opened, the check valve is closed, the drain valve is open because of the water pressure, this valve being held closed by atmosphere during priming, and the solenoid priming valve is closed because the centrifugal pump in starting builds up a pressure sufficient to close this valve, it being released by the solenoid when the centrifugal pump was started and the priming pumps shut down. It is seen from the foregoing that no water enters the priming pump, hence the name "dry pump."

Fig. 4 shows an elementary control layout utilizing the features previously outlined, and also the protective devices. The selective switch *S* and *S'* must first be closed to either the hand operation or automatic position. Assuming automatic operation, with the sump float switch *FS* and *FS'* closed, a circuit is made from line *L*1 through the float switch *FS* selective switches *S*, stop push-button *B*, bearing-temperature relay *T*, reverse-phase relay *P*, centrifugal-pump overload relay *OL*, contacts of the definite-time relay *DT*, and the coil of control relay *CR*1. The latter closes its contacts *CR*1, but this circuit is still open. A circuit is also made through the normally closed contact of relay *CR2*, the priming-pump overload-relay contact *OL'* and coil *PS* of the priming-pump starter. A third circuit is through the timing relay coils *DT* and reset button *RS*.

The definite-time relay *DT* consists of a magnet coil and a motor as indicated, with the necessary circuits and contacts. When the magnet coil is energized, contacts 1 and 2 close instantly. The motor coil, being energized, moves a gear train and a tripping mechanism. When the limit of travel is reached according to the time setting, contacts 1 and 4 are broken and 1 and 6 are made. Should the pump fail to start, contacts 1 and 4 will open and interrupt the circuit of relay *CR*1 and of the priming-pump starter coil *PS*, thus shutting down the motor. When the definite-time relay contacts open, contacts 1 and 6 are closed and sound an alarm or light a lamp.

Energizing the circuit through the priming-pump contactor coil *PS* closes its switch and throws the priming pump on the line. The priming pump continues to run until the centrifugal pump is primed, at which time the vacuum-breaker switch *VB* will close and make the circuit from line *L*1 through contacts *VB'*, the contacts of *CR*1 relay, one side of the float switch *FS'*, through one side of the selective switch *S'* and coil *CR2*. Relay coil *CR2*, being made alive, will close contacts *CR2'* and *CR2"* and open contacts *CR2*. Contacts *CR2*, when opening, interrupt the circuit for the priming-pump starter coil *PS* and this pump is shut down. The closing of contacts *CR2"* completes a circuit from *L*1, through coil *CP* of the centrifugal-pump motor's line contactor and this motor starts.

Starting Is Completed

As the centrifugal pump comes up to speed, a pressure is built up in the pump casing. When the pump reaches approximately full speed, the pressure in its casing is sufficient to close contacts *PR* of the pressure regulator and establishes a holding circuit for relay coil *CR2*. This circuit is from *L*1 line through *FS* pole of the float switch, contacts 1 and 2 of the definite-time relay *DT*, contacts *CR2'*, *VR*, *PR*, *FS'*, coil *CR2*, to the *L*2 line.

The vacuum breaker during this time is being emptied, and finally a point will be reached where its switch *VB* and *VB'* opens. The control-relay coil *CR2* is now in series with the contacts in the holding circuit, previously described. When the water is pumped out of the sump, the float switch opens and breaks the holding circuit for *CR2*, at *FS* and *FS'*, which shuts down the centrifugal pump.

It was assumed in the foregoing that no trouble is encountered during the starting cycle. There is, however, the possibility that the pump may fail to function as intended. For instance, the switch in the pressure regulator might not close, which would indicate that the pump failed to build up sufficient pressure, caused by (1) a broken discharge pipe, (2) insufficient inflow of water caused by a blocked intake line, (3) air enters the pump casing through leaky joints in the suction line or through faulty packing at the bearings.

After the pump has been primed and started, if the pressure regulator fails to close, contactor *CR2* will then open because its holding circuit is broken when the

vacuum-breaker switch *VB* and *VB'* opens. The float switch is still closed, consequently the definite-time relay *DT* is energized, and is timing out. When relay *CR2* opens, contacts *CR2* in series with the priming-pump line-contactor coil are again closed, and the priming pump will restart and prime the centrifugal pump, which will start as before when the vacuum breaker switch closes. This cycle is repeated each time the centrifugal pump fails to continue running, until the definite-time relay completely times out. When this occurs, the priming-pump line-contactor circuit is permanently broken at 1 to 4 and a circuit is made from 1 to 6 for a bell alarm or indicating lamp, Fig. 4, to let the operator know that the pump has failed to start. The push button *RS* may then be pressed, de-energizing the definite-time relay, allowing it to return to its original position for restarting the equipment. The time of this relay may be adjusted for three or four starts of the pump in a definite length of time.

One of the difficulties encountered in operating a centrifugal pump is that, when it once fails to prime and shuts down, the priming pump will immediately re-start, while the centrifugal pump is rotating with water in the casing. The pump cannot be primed in this condition, because all the air cannot be drawn out of the casing. To overcome this difficulty, a definite-time relay is connected in the priming-pump circuit to delay the re-starting of this pump and to allow the centrifugal pump to come to a standstill before beginning to prime it for the next starting operation.

The double-pole vacuum-breaker switch is used as a protective device as well as a starting device. With one pole of the switch connected in parallel with one pole of the float switch when operating automatic, if the vacuum-breaker switch should stick and fail to open, the pump would be shut down when the float switch opens, but the definite-time relay *DT* would still be energized independently of the float switch, through conact *VB*. The relay would then time out and break its contacts 1 to 4, and prevent the priming pump from restarting.

If the float switch should stay closed and keep the centrifugal pump running, the sump would finally be pumped below the discharge line. The centrifugal pump would therefore lose its vacuum, and the vacuum-regulator switch *VR* would open and break the circuit for relay coil *CR2*, which, in turn, would shut down the centrifugal pump.

WHEN COLLECTING FLUE GAS from the outlet of a boiler it is common practice to use common iron pipe for the sampling tube. If the temperature of the gas being sampled is sufficiently high to raise the temperature of the sampling tube to 750 deg. F. an iron tube should not be used. When the temperature of the iron reaches 750 deg. F. it starts to react with the carbon dioxide in the gas forming iron oxide and reducing the carbon dioxide to carbon monoxide. Thus a sample of gas drawn through an iron pipe when at or above this temperature would have its composition completely changed, appearing to contain high carbon monoxide and low carbon dioxide. For sampling at these high temperatures the tube should be made of silica or clay, or be fitted with a water jacket so it may be cooled. The reaction of iron with the flue gas is one of the many factors that make the collection of a representative gas sample at best a difficult undertaking. Preparations should be made carefully with regard to individual conditions.

What Do You Know?

The answers are on page 280

LORD KELVIN once stated that nothing became a science until it was measurable; consequently, we can say that there is an electrical, a geological and an engineering science. As yet, since it cannot be measured, *living* is not a science. Certainly we agree that an athlete is more living than a person of seventy, if the unit of measurement be the muscular output. But is this a real measure of living? After all, is not what we know a better unit? If so, how alive are you? Can you correctly answer the ten questions below, or are you only half alive? Measure yourself by checking with the answers.

Ques. 1—For what is dummy packing used?

Ques. 2—What is the locomobile type of engine, and has it ever been built in the United States?

Ques. 3—Where is a large part of the total resistance of an artificial ground connection, such as a driven pipe, normally found?

Ques. 4—In terms of the weight of an elevator car and its rated load, what is the usual weight of the counterweights?

Ques. 5—If tube holes in a boiler are punched $\frac{1}{8}$ in. small and reamed to size, will the boiler meet the A.S.M.E. Code requirements?

Ques. 6—Is there any plant in the United States where steam generated by the earth's internal heat is used in a power plant?

Ques. 7—Is any of the energy required to drive the compressor of a Diesel engine returned by the spray air when introduced into the cylinder with the oil?

Ques. 8—In a steam plant why cannot the condenser pressure be known by simply obtaining the temperature and ascertaining the corresponding pressure from tables of the properties of steam?

Ques. 9—How can gage glasses be cut?

Ques. 10—If a fan was to be installed to handle air for heating, does it require less horsepower to drive the fan when it is placed ahead or after the heating coils in the system?

Crankcase Scavenging of a Two-Stroke-Cycle Engine*

By Otto Holm, Hamburg

TEST of a two-stroke-cycle engine with crankcase scavenging—Effect of changing the height of the scavenging and the exhaust slots upon the scavenging efficiency, determined by analysis of the gases

THE ordinary crankcase scavenging pumps of two-stroke-cycle engines are generally noted for their low volumetric efficiency. This is due to the excessively large clearance space of the crankcase, which under the most favorable conditions is equal to four or five times the piston displacement volume. Very few test data on the volumetric efficiency of scavenging pumps are available. The uncertainty that prevails with regard to the amount of air delivered by scavenging pumps shows its effect in the divergency in the measurements of the scavenging and exhaust slots. These differ greatly in practice.

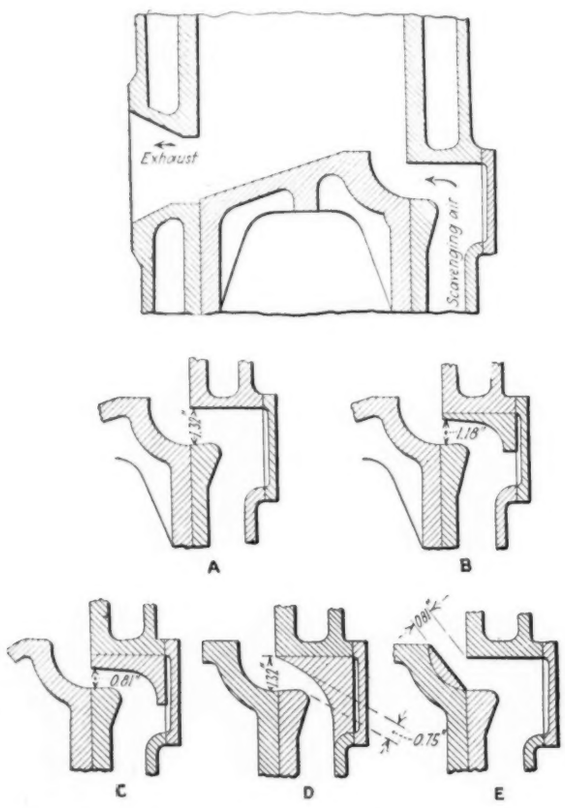


Fig. 1—Dimensions of exhaust and scavenging ports

For this reason the influence that different dimensions of these slots exert on the efficiency of the scavenging process was carefully investigated on a 15-hp. hot-bulb engine. In this connection it may be stated that the working cycle of the engine is of small consequence so far as the conclusions obtained from the test results are concerned, and the results would have been similar if the test had been made on a solid-injection Diesel.

In addition to the usual temperature observations, such as that of the entering and leaving cooling water, scavenging air, exhaust, and hot-bulb, it was necessary also to measure the spaces from which the gases were taken for analysis, in order to calculate the weight of the gases contained therein, both immediately before and after the scavenging operation. For this purpose the cylinder wall and exhaust manifold were drilled in several places and equipped with special mechanically operated sampling valve pipes, through which samples of the gases could be withdrawn.

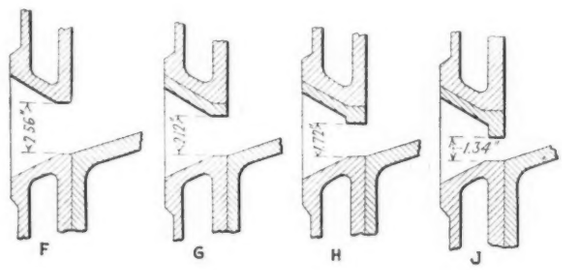


Fig. 2—Exhaust ports used in tests

Method of Analysis

Analyses of the gases sampled from the cylinder, immediately before and after the scavenging period, were used to determine the efficiency of the scavenging process and the amount of clean scavenging air entering the cylinder. The moisture in the gas known from the elementary analysis of the fuel, 86.82 per cent C., 13.18 per cent H_2, no O_2, and no HS_2, was taken into consideration. The calculation of the useful scavenging air volume and the effectiveness of the scavenging was based on the fuel consumption and scavenging air intake as the only measure values.

It is a remarkable fact that no, or only a slight, trace of CO is present in the exhaust gases of oil engines, even if they are overloaded and are smoking badly. When there is a deficiency in the air, the fuel apparently is transformed into soot and most of it escapes unconsumed through the exhaust pipe. This condition makes it difficult to calculate the amount of effective

*Abstract of article appearing in *Zeitschrift Des Vereines Deutscher Ingenieure.*

scavenging air, as it is impossible to measure the escaping vaporized fuel by gas analysis or other methods. The results obtained by these tests, therefore, constitute only the higher limits. Under smokeless combustion the test values are nearly correct, whereas, with a smoking exhaust, the values obtained are too high. It is evident that the calculated efficiencies of the scavenging operation correspond to the actual, even if appreciable quantities of unconsumed fuel are not detected by the gas analysis.

The first group of tests was intended to show the

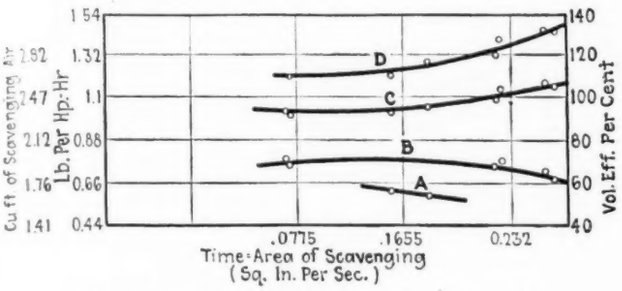


Fig. 3—Results plotted against scavenging

A. Specific fuel consumption of No. 1 group of tests.
B. Specified fuel consumption of No. 2 tests.
C. Volumetric delivery of crankcase scavenging.
D. Volume of air drawn in during one revolution.

effect on the scavenging cycle of varying the height of the exhaust slots. In both groups of tests the 5.65-in. width of both slots remained unchanged. The third and fourth groups of tests showed the influence of changing the shape of the scavenging ports and the top of the piston. Interchangeable filling-in pieces, as illustrated by Figs. 1 and 2, were provided for the purpose of changing the shape and height of the scavenging and exhaust slots.

Test Conditions

All tests were made with the engine running at two different speeds—at 450, designated as *A*, and at 290 r.p.m., designated as *B*.

TESTS OF AIR AND EXHAUST PORTS

Group I

Test No.	1	2	3	4	5	6	7	8
Filling pieces	AF	AF	BF	BG	AF	BF	CG	CF
Speed	B	B	B	B	A	A	B	B

Group II

Test No.		5	9	2	10	11	12	13
Filling piece	AF	AF	AG	AG	AH	AH	AJ	AJ
Speed	B	A	A	B	B	A	A	B

Group III

Test No.	14	15	16
Filling piece	DF	DF	DG
Speed	A	B	B

Group IV

Test No.	17	18
Filling peice	EF	EJ
Sped	A	B

The results of the tests in graphic form, referred to "time-area" in square centimeters per second of the exhaust and scavenging periods, as abscissas, are shown in Figs. 3 to 6. The "time-area" of the scavenging is the integral of the area of the open scavenging slots from the beginning of the opening to the full closure of the slots by the edge of the piston top and the time interval. Similarly, the "time area" of the exhaust is the integral of the product of the exhaust slots opening and the time interval between the opening of these slots and the time the scavenging ports are fully opened by the piston. The amount of gases entering the cylinder is equal to the ratio between the gas volume calculated from the gas analysis and the measured fuel consumption, wherein the gas volume is figured at 60 deg. F. and atmospheric pressure to the cylinder volume, at the closing of the exhaust slots.

The test results of the first group show a volumetric efficiency of the scavenging pump greater than unity, with a sufficiently large "time area." During the second group of tests the engine continued to operate well when the exhaust and the scavenging slots were of equal height.

During most of the tests a small exhaust pot, having a volume of 1.12 cu.ft., was in use. As the high volumetric efficiency of the scavenging pump may have been due to the inertia effects of the gases in the exhaust manifold, supplementary tests were made with an exhaust pot having a volume of 16.4 cu.ft. The volumetric efficiency proved to be less, but remained constant, whereas with the small exhaust pot in use the efficiency varied in accordance with the resonance effect of the pulsating exhaust, which varied with the speed of the engine.

In Fig. 6 the high points of curves *C* and *E* were obtained during the test run at 450 r.p.m., whereas the low points correspond to the test runs at 290 r.p.m. As a whole, the results obtained with the larger exhaust pot were less favorable. It appears, therefore, that the best results are not always obtained from two-stroke-cycle engines if the gases are permitted to exhaust freely.

Influence of Exhaust Slot Height

With a small-height exhaust slot an increase in the usual stroke of the pump will improve the efficiency. The influence of the exhaust slot height upon the specific fuel consumption is shown graphically in Fig. 4, by the curve *C*, which was plotted from values calculated from the test results, to correspond with an equal useful pump stroke. It may safely be assumed that the fuel consumption varies inversely with the piston displacement.

Another advantage with a small height of exhaust

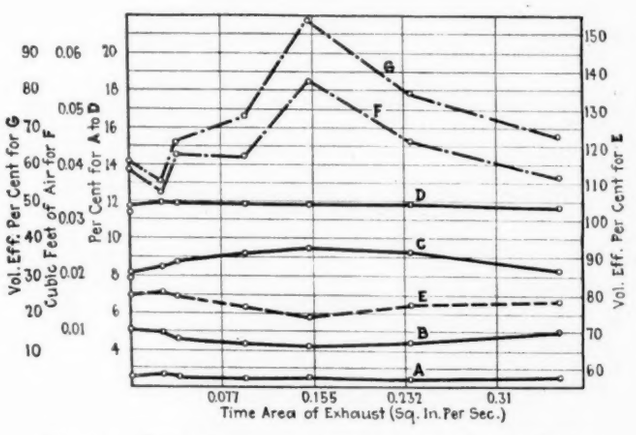


Fig. 4—Combustion results plotted against exhaust

A. CO_2 content at beginning of compression.
B. CO_2 content at end of expansion.
C. O_2 content at end of expansion.
D. O_2 content at beginning of compression.
E. Scavening efficiency.
F. Useful amount of scavenging air.
G. Filled volume of cylinder.

slot, may have resulted from the somewhat higher compression and the lesser variation in the pressure difference between the cylinder and the scavenging pump during the scavenging operation. This would minimize eddy currents, which would entirely offset the inertia

effects of the gases exhausting into the crankcase.

The test results were confirmed by tests on several other engines. For instance, it was possible to obtain 31.4 hp. from a 25-hp. engine in which the scavenging slots were comparatively high and the exhaust slots low in height. This engine had a cylinder diameter of

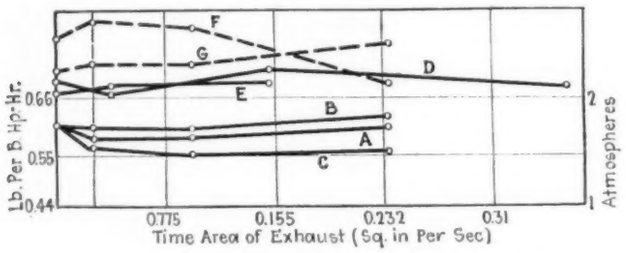


Fig. 5—Variation with size of exhaust pot

A. Specific fuel consumption, No. 1 group, with small exhaust pot.
B. Specific fuel consumption, No. 1 group, with large exhaust pot.
C. Reduced specific fuel consumption.
D. Specific fuel consumption, No. 2 group, with small exhaust pot.
E. Specific fuel consumption, No. 2 group, with large exhaust pot.
F. Largest useful m.e.p., No. 1 group, with small exhaust pot.
G. Largest useful m.e.p., No. 1 group, with large exhaust pot.

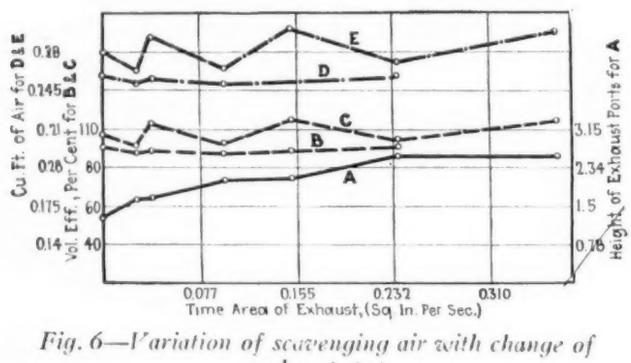


Fig. 6—Variation of scavenging air with change of exhaust pot

A. Height of exhaust slots.
B. Volumetric delivery of scavenging pump, with large exhaust pot.
C. Volumetric delivery of scavenging pump, with small exhaust pot.
D. Volume of air drawn in, with large exhaust pot.
E. Volume of air drawn in, with small exhaust pot.

8.25 in., a 13.4-in. stroke and ran at 400 r.p.m. This corresponds to an m.e.p. of 44 lb.

The form *D* filling-in piece for the scavenging slot, shown in Fig. 1, gave a poor scavenging efficiency, which was undoubtedly due to the fact that the scavenging air stream escaped across the piston top into the exhaust slot.

Why Small Pot Is Better

An explanation as to why the small exhaust pot appeared to show more favorable results is not difficult. The momentum of the exhaust gases, when the exhaust pot is not too large, may cause scavenging air to be sucked into the cylinder, after the scavenging pump has completed its stroke, which would show a very high volumetric efficiency. Doubtlessly, improvements based on this phenomenon are possible. It must be remembered that it is poor policy to destroy the inertia energy of the gases by employing exhaust pots that are too large. On the contrary, this momentum should be made to do useful work, and this is possible only in passages so shaped that no sudden small increase in area occurs. A study of the resonance effects may also lead to their application to perform useful work.

Answers To What Do You Know

The questions are on page 277

Ans. 1—This prevents steam leaking along the revolving rotor of a reaction turbine. The steam enters the blading at high pressure and the dummy packing prevents it from leaking away from the blades. A large diameter is necessary at this point in order to equalize the thrust of the steam. This is usually double labyrinth with close radial and axial clearness.

Ans. 2—The locomobile consists of a high-pressure engine mounted upon the boiler. Usually, a superheater is placed in the smoke connection, and in some designs the engine cylinder is surrounded by the boiler steam dome. This unit is for stationary power-plant service. A number were built a few years ago by the Buckeye Engine Company, Salem, Ohio.

Ans. 3—Actual measurements made by the United States Bureau of Standards showed that in the case of driven pipes about 90 per cent of the total resistance is generally encountered in the first six to ten feet of earth surrounding the pipe. These investigations also showed that when alternating current was used the contact resistance between a clean pipe and earth was negligible.

Ans. 4—Equal to the weight of the car plus 40 per cent of the rated load.

Ans. 5—No. The holes must either be drilled full size, or punched at least $\frac{1}{2}$ in. smaller and then drilled, reamed or finished to full size with a rotating cutter.

Ans. 6—In 1921 J. D. Grant started to drill wells at the geysers in Sonoma County, California. The steam pressure obtained from several wells was high enough to justify the planning of a power plant, but so far actual power has not been developed.

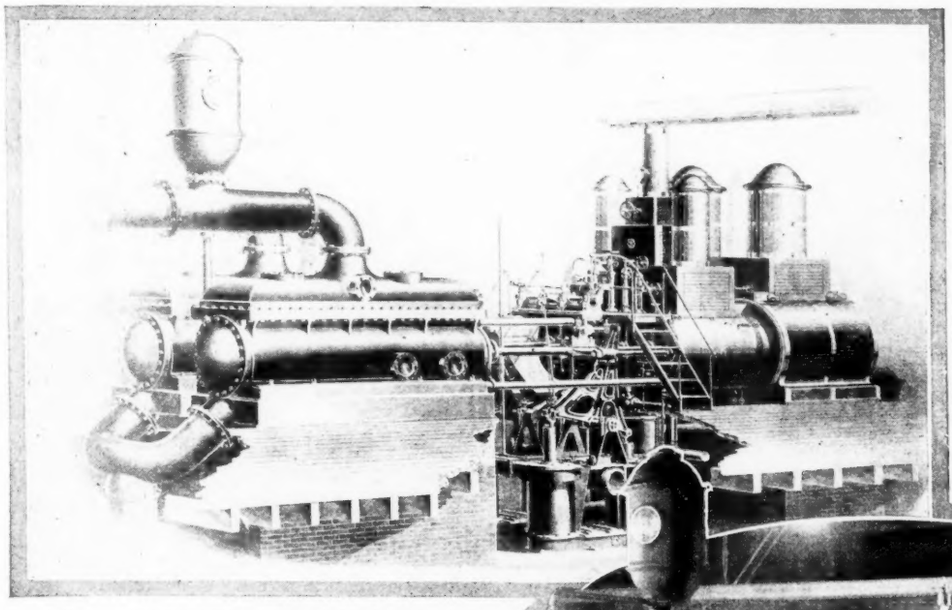
Ans. 7—The spray air mixes with the other cylinder contents and either in combination with the carbon or as excess air is rejected at the exhaust temperature of, say, 700 deg. F. Since it entered the cylinder at less than 200 deg. F., not only does it not return heat but actually absorbs more heat. However, it has the practical advantage of insuring excellent fuel and air mixing.

Ans. 8—The absolute pressure within a condenser is made up of the pressure due to the steam or water vapor present and the pressure due to the gases present, generally called air, as the greater part of such gases usually consists of air. The total condenser pressure cannot be obtained from steam tables because the temperatures given in the tables are those corresponding to the pressure of the saturated steam only, which pressure would be something less than the total pressure, depending on the amount of "air" contained in the mixture.

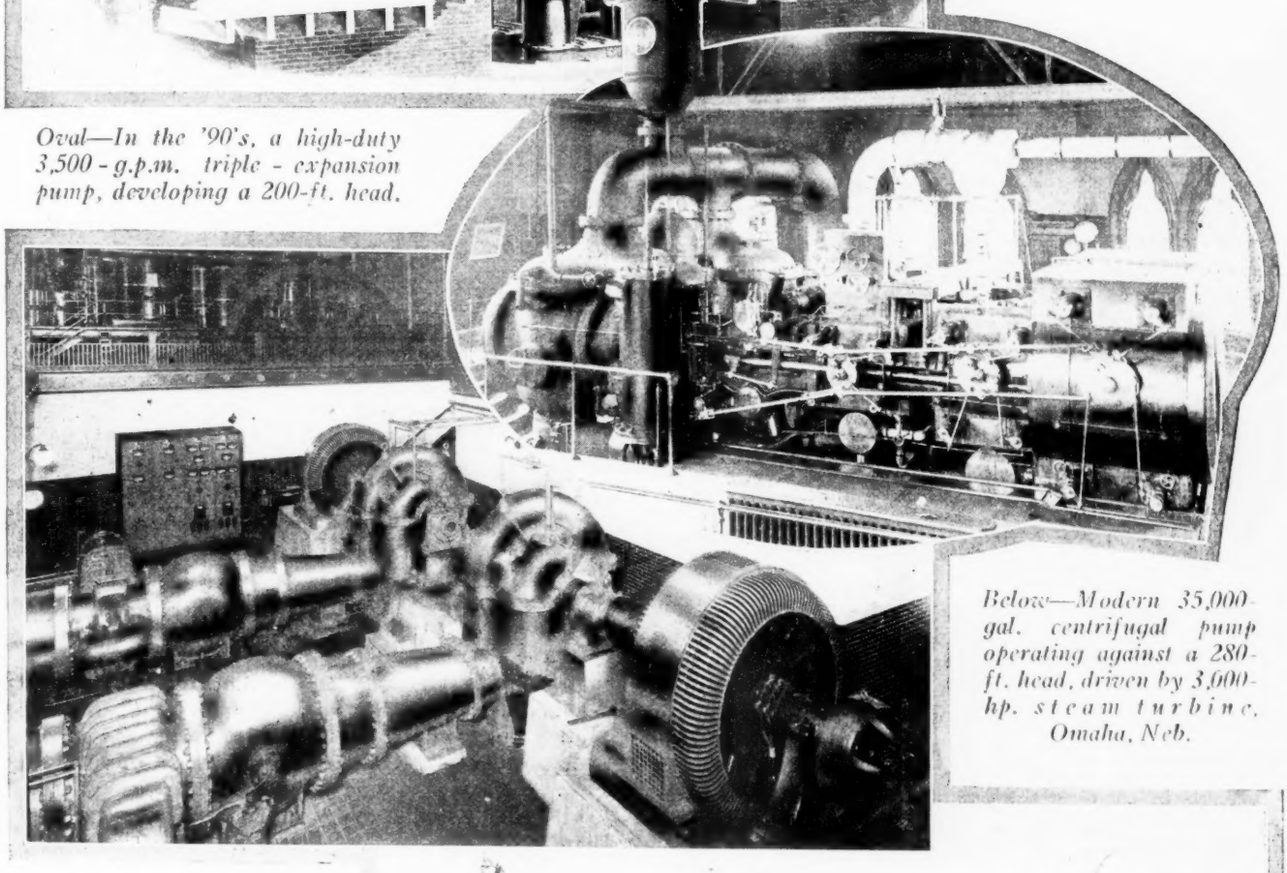
Ans. 9—Thin glass tubing can be broken off at desired lengths by first making a scratch around the tube with a sharp three-cornered file. Then grasping the tubing firmly in both hands with the thumb nails coming together at the scratch, the tube is bent, whereupon it will break squarely at the scratch. With a little practice tubes of uniform thickness can be broken in this manner to the desired length with few failures from breakage.

Ans. 10—The horsepower required to drive a fan varies directly as the absolute temperature of the gas it handles, even though the weight of gas and the total head in inches of water remain constant. If the fan were installed to handle the hot outlet air instead of the colder inlet air, the horsepower would be increased in proportion to the absolute temperatures. It is thus of prime importance for the designer to locate fan equipment so that it receives the coolest gas possible.

Chapters in Water-Works Development Tell of 50 Years' Progress

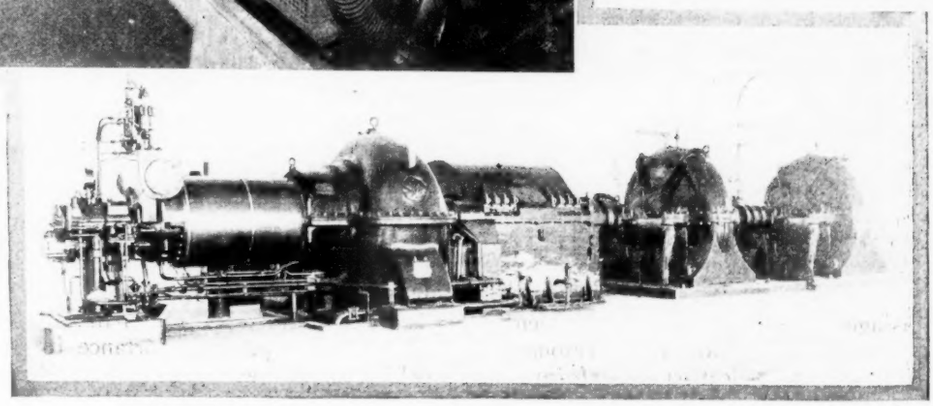


Left — This compound water-works pump, typical of practice fifty years ago, pumped 7,000 g.p.m. against a 150-ft. head. This pump was in operation at the Fall River pumping station in 1876.



Oval—In the '90's, a high-duty 3,500-g.p.m. triple-expansion pump, developing a 200-ft. head.

Below—Modern 35,000-gal. centrifugal pump operating against a 280-ft. head, driven by 3,000-hp. steam turbine. Omaha, Neb.



Above—These 1926 centrifugal pumping units, Detroit Water Works, operate against 175 ft. head. One, 35,000 gal. capacity, is driven by a 2,000-hp. motor; the other, 49,000 gal., by a 2,700-hp. motor.

Do Your Own Inspecting

Advises a Boiler Inspector

By Peter J. Lyons

AN EXPERIENCED boiler inspector feels that the engineer should examine the boilers between the inspector's trips. He outlines the reaction of the average engineer to this advice.

"THAT'S one load off my chest, Wolfe," grunted Brown, the chief engineer, after Wolfe, the inspector, had finished his work and was washing up. "We won't need to bother until you show up next year."

"That's where you are wrong, Brown," Wolfe gurgled as he buried his face in the cool water. "A lot of you engineers think the whole job of making your boilers safe is up to the boiler inspector.

"That's the greatest mistake you can make," he declared emphatically. "Every engineer should make, or have someone under his jurisdiction make, a thorough inspection between the regular visits of the inspector."

"But I don't know what to inspect," protested Brown. "I'm an engineer and you're a boiler inspector. I shouldn't be expected to do your work any more than you should be told to run my engines."

"You're wrong, my boy. Every engineer should familiarize himself as to what structural defects to fear and where they are most likely to occur.

"Our insurance company," Wolfe continued, "insists that I make an internal inspection once a year, but my experience has been that one should take nothing for granted, and the engineer should make at least one internal inspection between my visits."

"But say," protested Brown, "these are not second-hand, junk-shop boilers, but were made in one of the best boiler shops in the country. Talk about your 'structural defects'—they don't exist in these fellows."

"Even in the best-equipped shops," Wolfe dryly replied, "where every precaution is taken to comply with boiler-code rulings, and where the workmanship is the highest, the inspector takes nothing for granted. Mistakes will occur with all of us."

"Don't tell me that a good shop could build a defective boiler," scoffed Brown. "Steel mills wouldn't dare to ship bad steel and a good boilermaker couldn't help but do a good job."

"Don't fool yourself," retorted the inspector. "A case comes to my mind of a drum shell plate of a water-tube boiler which, when rolled, had the appearance of a perfect plate. But when the throat opening was burned out with an acetylene torch, the sheet was found to be in two layers. Investigation revealed that the layer structure existed over a greater part of the sheet, although the mill tests proved the plate to be up to code requirements."

"That wouldn't happen again in a thousand years."

"I will grant that it was a rare case," conceded the inspector, "but it shows that any boiler may have an invisible defect, which may prove dangerous when the boiler is put into service."

"That's what your factor of safety is for," parried Brown. "If you knew all about a boiler, you wouldn't need any safety factor of 5. From what you say, it ought to be called 'the factor of ignorance.'"

"Maybe so," conceded Wolfe. "At any rate, it's a good thing to limit the boiler pressure to one-fifth of what the steel is calculated to stand. Anyway, you should inspect your boilers between the regular inspections for many other reasons. As these are water-tube boilers, I would suggest that the tube ends be looked at frequently to determine if they are pulling out of the tube sheet, and if there are any bent or sagged tubes those ends particularly should be watched, as not infrequently inspectors find tubes partly out of tube sheets; a little more sagging of the tubes and they are out completely, with disastrous consequences."

"A case comes to mind of an accident in 1925," Wolfe said, again growing reminiscent. "One of the front tubes of a Stirling type boiler pulled out of the tube sheet of the front upper drum when there was 125-lb. pressure on the boiler. One can readily visualize what happened. This tube, suddenly freed, discharged steam at a high velocity, while the free end of the tube whipped around, knocking out several adjoining tubes and bending sixty others so badly they had to be removed."

"But I don't know anything about inspecting," objected the engineer. "Where am I to look for trouble?"

"I might suggest the following procedure for inspecting a water-tube boiler, reference being made to structural features only. Starting at the furnace, look for bags and blisters, and if tubes are bent or sagged, observe the tube ends. If the boiler was of the staybolted water-leg type, I would be sure to see if the bottom of the

water leg is exposed, as scale settles at this point and unprotected bags or fire cracks will occur.

"If the boilers were of the type with mud drums, the connecting nipples and mud drums should be cleaned of soot and carefully examined. It should be observed that all tubes, nipples and seams are free from leakage.

"Next, the drums should be entered to inspect the drum heads. Go over the heel of the flange very deliberately, for cracks. It must be remembered that there is a constant breathing action at this point and this flexure over a course of years is likely to cause cracking."

"You are laying out a lot of work for me," Brown commented without enthusiasm.

New Heads Sometimes Show Cracks

"Any person who has witnessed the damage done by the explosion of one of those heads will not neglect this vital point," Wolfe continued in spite of the interruption, mentally looking back through his years of varied experiences. "In one plant consisting of six boilers I found three cracked heads. Two of the boilers were 25 years old, and on the third the cracked head was one that was renewed two years previously. Careful inspection of bumped heads cannot be overemphasized.

"But getting back to your boilers, the internal feed line should be examined at the point of discharge, and often it will be found partly choked with scale and sediment. Examine the openings to the water column and look for pitting and corrosion. Likewise, examine the seams for grooving.

"The most common defects found in fire-tube boilers are bags, principally on the first course, and fire cracks at the girth seam. If tubes are leaking at rear ends, it should be observed if scale is forming at the intersection of tubes and rear head. Blowoff pipes should be examined and protected from flames."

"We have a yard engine, so you'd better give me some dope on it," Brown ventured, with the idea of getting Lyons to stay a while longer, for in spite of the inspector's flow of advice, he was well liked by engineers.

"In locomotive-type boilers, and a great many are used in stationary work, the firebox is the chief source of trouble. The grates should be removed and the inside corners examined carefully. Plates at this point get thin when a boiler is not in service, dampness and even a small percentage of sulphur in the coal having a deteriorating effect. It is imperative that the crown sheet be kept clean, or fire cracks and warping between crown bolts will make their appearance. The staybolts should be sounded, and to find fractured bolts requires considerable practice and experience."

"Might as well tell the whole story. What about a vertical boiler?" Brown put in.

Where to Look for Defects in a Vertical Type of Boiler

"In a vertical tubular boiler the grates should always be removed for the annual inspection. The chief source of trouble is scale forming on the bottom head at tube ends, causing frequent renewals and cracks of the ligaments, usually referred to as bridges between the tubes. Inspection of the top tube sheet should never be neglected. Take the smoke hood off if necessary. If the boiler is out of service for a while, the damp soot corrodes tube sheet and tube ends."

Wolfe liked to talk over unusual accidents he had encountered, so branched off into the years spent in the South. "Over a period of fifteen years of inspection work, I have encountered some unusual things. In a Southern town in a coal-and-iron district, a large number of track locomotives were in use. My attention was called to trouble they were having with fusible plugs in one particular locomotive. Upon three successive days the plugs had blown. Examining the crown sheet, we found it clean and I was informed that the filling used was the same as used in other boilers, working under the same conditions. Another new plug was put in, and the boiler superintendent rode all day on the locomotive, trying the gage cocks; yet the plug blew and an expert was called from a distant city. After analyzing the plug filling and going over all phases of the situation, he admitted it was a puzzle. However, the trouble stopped and no one was certain as to the cause.

"An accident at a rolling mill happened at night. Evidently, the attendant had been sleeping soundly and practically all the water in the boiler was evaporated, the tubes melted and there was three inches of molten metal in the tube ends of the mud drum. No explosion occurred, and the tubes over the fire appeared simply to melt away.

"I've talked too much," he concluded. "I ought to bill you for the time. But if it will induce you to do a little inspecting of your own, it's worth while. It's train time, and I must catch the rattler; here is hoping you turn inspector!"

Successful Trials of Large Motorships With Büchi-exhaust-turbo-charging

By Alfred Büchi

DURING the last of June the trial trips of the two motorships, "Hansestadt Danzig" and "Preussen," took place. In each ship are two 10-cylinder single-acting MAN-Vulcan four-stroke-cycle Diesels. With each ship a six hours' run under high speed was accomplished, during which a mean speed of 20.2 knots was attained. For this speed an output of 8,050 hp. was needed for the twin screws, and this was easily generated with the engines working with exhaust-turbo charging. On the high speed of 20.2 knots the engines turned at 317 r.p.m. and a mean effective pressure of 118 lb. per sq.in. was reached, the exhaust being at this charge absolutely clean and invisible. The mean effective pressure of an ordinary four-stroke-cycle Diesel engine is generally not higher than some 67 lb. per sq.in. These facts prove that the necessary air excess for the complete combustion was present.

The tests were remarkable because of the high-speed engines. It can be granted that for the ordinary low-speed marine engines the results would be even better than these.

When the engines are running without supercharging, as ordinary Diesel engines, the output is 1,700 b.hp. per engine at 240 r.p.m. The total increase in output of the super-charged engine was therefore 138 per cent and the increase in mean effective pressure was about 75 per cent.

This indicates that an increase of power of from 45 to 50 per cent over the normal output of ordinary Diesel engines of the same cylinder dimensions and speed can be continuously generated with the exhaust-turbo scavenging design. The engine can be even worked with a 75 per cent increased power for a long period.

Large Slow-Speed Vertical

Waterwheel Generators Have Special Features

By M. W. SMITH

Power Engineer, Westinghouse Electric & Manufacturing Company

IN THE design of the large slow-speed vertical-shaft waterwheel generators, for the Conowingo development of the Susquehanna Power Company and for the Coosa River, Lock 18 plant of the Alabama Power Company, special consideration was given to electrical stability. For this reason the machines for both developments are being specially designed to obtain high-speed excitation.

THE advantages of quick response excitations as a means of maintaining stability and keeping synchronous machines in step during line faults and disturbances, have been given considerable attention recently. In the case of high-speed machines (approximately 500 r.p.m. and above) a sufficiently quick change in voltage can usually be obtained from direct-connected exciters by dividing the fields of the exciter into parallel circuits and adding resistance in each parallel path to improve the time constant of the exciters. In some cases further increase in speed of voltage response is obtained by providing a second direct-connected exciter for separately exciting the main exciter.

Even this latter arrangement will not produce a sufficiently high rate of response on low-speed machines, such as those referred to, where stability is of primary importance. This is because of the inherent sluggishness of slow-speed exciters operating at about 100 r.p.m. or less. It has been found advisable to resort to the more complex scheme of using auxiliary generators in order to obtain the desired rate of voltage response. In this arrangement auxiliary alternating-current generators mounted above, and direct-connected to, the main generator, supply power to high-speed (1,200 r.p.m.) motor-generator sets, which in turn supply excitation to the main generators.

These auxiliary generators have their own direct-connected exciters mounted above them, at the top of the unit. The direct-current generators of the motor-generator sets, in addition to having their field coils connected in parallel circuits, to reduce the equivalent inductance, have direct-connected teaser exciters which supply them separate excitation. With this arrangement and method of excitation it is expected that the rate of response in excitation will be greater than 675 volts per second. On some slow-speed units high-speed exciters, gear driven from the mainshaft, have been considered and look promising. The auxiliary generators also supply a small amount of power for the turbine and station auxiliaries.

The Conowingo machines have a rating of 40,000 kva., 13,800 volts, three-phase, 60 cycles, 81.8 r.p.m., and the ultimate capacity of the station will be eleven units with a total capacity of 440,000 kva. Seven of these machines will be installed initially.[1] The outside diameter of the generator frame, Figs. 1 and 2, is approximately 37 ft., and the over-all height above the surface of the frame support is approximately 23 ft. Each unit weighs over a million pounds, and the combined weight of the rotor and water thrust which must be supported by the upper bracket and thrust bearing is 1,375,000 pounds.

The upper bearing bracket, Fig. 4, consists of a cast-steel hexagonal shaped center, to which six cast-steel arms are bolted and keyed. Made in halves, the upper guide bearing is arranged so that it can be removed from below. The lower bracket is fabricated from structural-steel shapes and the bearing and bushing are mounted so that they can be adjusted at right angles to the shaft. Space is provided between the shaft coupling and bearing housing to remove the lower guide bearing, which is also made in halves. When the rotor is to be removed, the removal of the bearing bushing provides space for the shaft flange to pass through the lower bracket.

The rotor spider, Fig. 3, consists of a cast-steel center made in halves on which a laminated rim is built up. This rim carries the laminated field poles and field coils.

Cast iron is the material used in the stator frames which are made in three sections. These are assembled in the factory so that the frame can be bored and machined as a whole. In addition to the three joints corresponding to the splits in the frame, there are two additional butt joints in each third of the core, making a total of nine sections into which the core is built. This construction has been found effective in preventing buckling due to expansion from temperature, which is often experienced on the shallow cores of large-diameter slow-speed machines of standard core construction. Another advantage of this construction is that any damage to the core can be repaired with a minimum disturbance to the stator. Each of the three sections of each stator will be shipped from the factory completely wound with the exception of the coils at the split of frame.

The construction of the four 29,000-kva., Lock 18, units is similar to that of the Conowingo machines, except for slight differences found advisable, owing to the smaller diameter of the former.

[1]Three of these units are being built by the Westinghouse company and four by the General Electric Company. The detail descriptions apply to the Westinghouse machines.

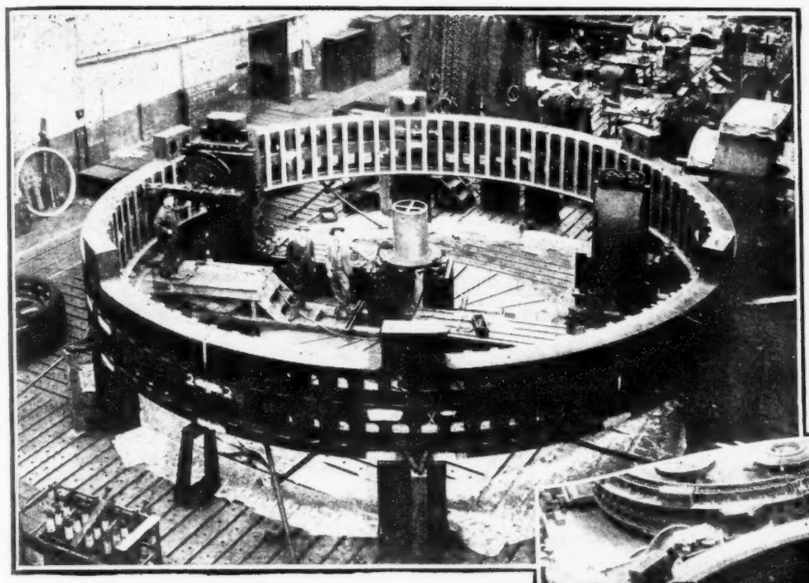


Fig. 1 (Left)—Stator frame of one 40,000-kva. Conowingo generator assembled in the shop. The outside diameter is approximately 37 feet. Each unit weighs over one million pounds and the load on the thrust bearing will be 1,375,000 pounds

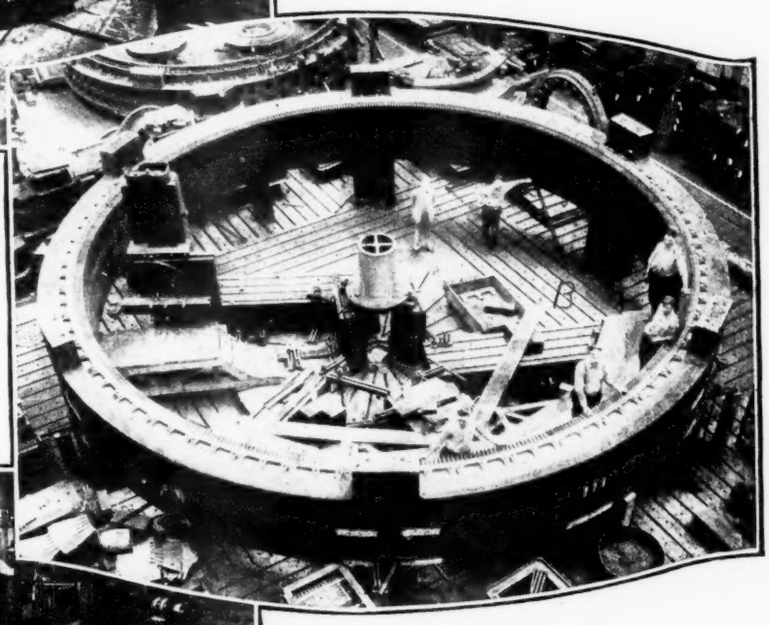


Fig. 2 (Right)—Stator frame with core assembled in the shop. The frame is divided into three sections and each section will be shipped with its winding in place

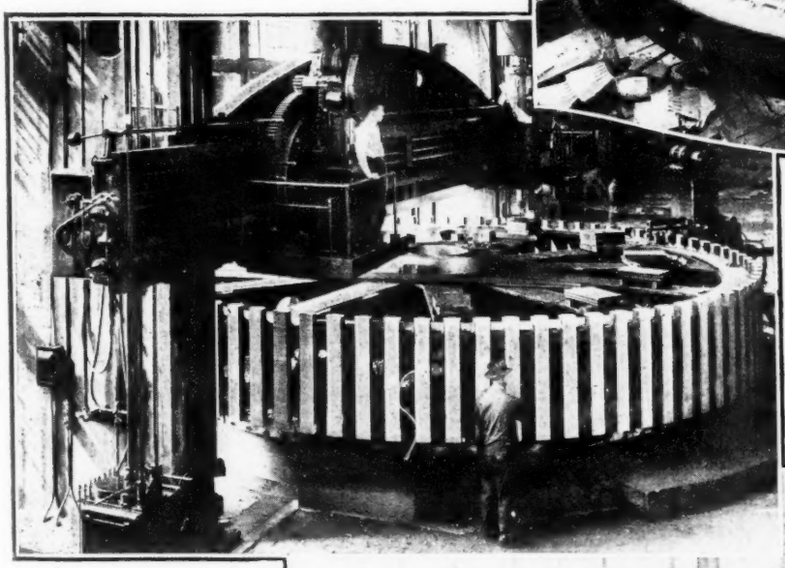


Fig. 3 (Left)—Cast-steel spider on which is assembled the laminated rim for one of the rotors

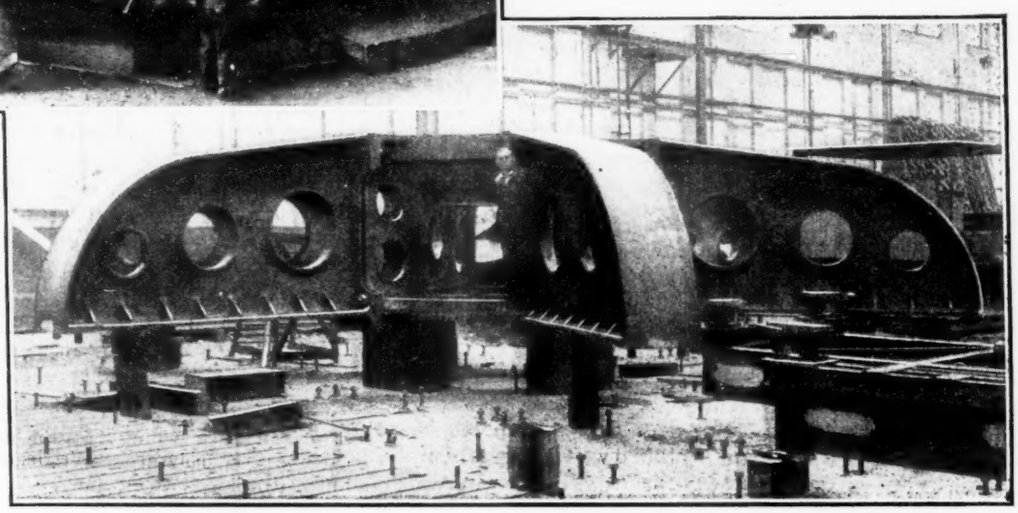


Fig. 4 (Right)—Upper bearing bracket, consisting of a cast-steel hexagonal center to which six cast-steel arms are keyed and bolted

A Remedy for a Case of Turbine Vibration

By J. Elmer Housley
Aluminum Company of America, Alcoa, Tenn.

An investigation of a rather severe case of vibration in a vertical turbine of 2,250 kw., operating at 900 r.p.m., resulted in a simple although effective remedy. It was discovered, upon checking over the turbine, Fig. 1, that an unbalanced field rotor was responsible for the trouble. The remedy consisted in placing a sufficient number of balance screws at the proper place on the rotor to overcome the unbalanced conditions.

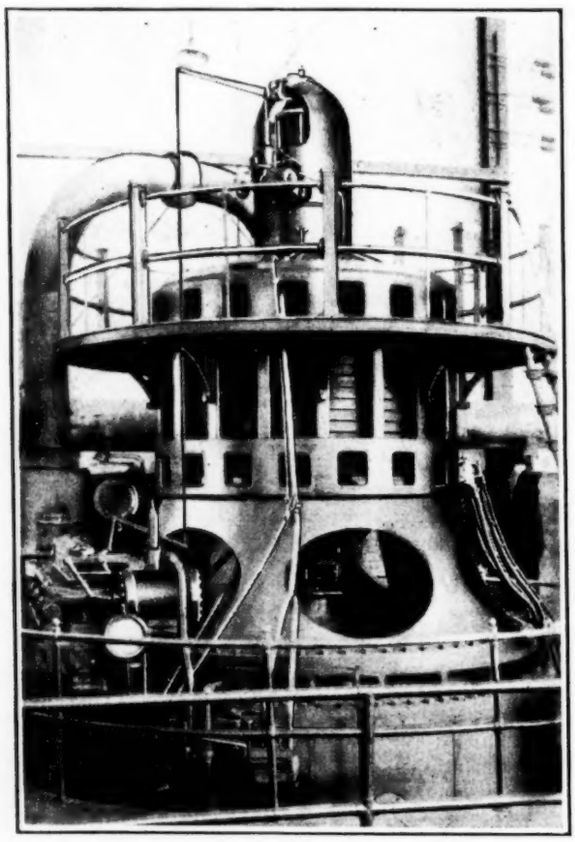


Fig 1—Vertical turbine on which a serious case of vibration was remedied

The vertical shaft which is built in one piece, carries four turbine wheels with two sets of blades on each wheel, and eight polepieces. This weight is supported on a cast step bearing about 14 in. in diameter. With the shaft revolving, the surfaces at the bearing are under an oil pressure of 400 lb. and are separated by an oil film.

Shortly after the vibration trouble started considerable oscillation of the hand on the step-bearing pressure gage was noticed and upon examination, the bearing was found to be cut and grooved. A new step bearing was put in, but this had no effect whatever on the vibration of the turbine.

A study of the situation brought up several other possible causes for the trouble: A section of the shrouding of the turbine wheels might have been thrown off; the turbine or generator sections might have become unbalanced; the shaft might be out of true; or the bearings might have become loose. Finally, the decision was reached to inspect the interior of the turbine—it had not been opened for several years—and to make a complete checkup of the unit. With the assistance of the manufacturer's service man, one section ($\frac{1}{3}$) of the shell was removed and a complete checkup started.

Upon inspection the wheels and blading were found tight and in good shape except for a few dented blades, which were straightened. The bearings were tested with feeler gages to determine the clearances and wear, but were found in satisfactory condition, although there had been some wear. (The turbine was about twenty years old when the vibration trouble started).

Next, the governor mechanism was removed and the shaft tested at the midpoint and at the top, Fig. 2, with a shaft indicator as the rotor was revolved by hand, the step bearing being under oil pressure. The midpoint of the shaft was found to be true, but the top ran out of true about 0.018 in. This situation indicated one of two conditions, either the shaft was bent or it was leaning or cramped by the field rotor.

In order to determine the facts, eye-bolts were inserted in the field rotor, which was pulled off by means of the station crane hoist. The hub of the first turbine wheel seated against the turbine cover and secured the shaft. After the removal of the field rotor the top bracket of the unit was replaced and was tested for its central location by revolving the shaft with a shaft indicator fastened to the shaft and touching the bore of the bracket. The shaft was also tested with the indicator and was found to be true. This was fortunate because otherwise it would have been necessary to dismantle the remainder of the generator in order to straighten the shaft.

The next move was to determine definitely the cause of the flexure of the shaft. Efforts were made to find out whether it was caused by an unbalanced condition of the weight of the rotor or by a cramping action of the rotor upon the shaft. The shaft was carefully cleaned and coated with white lead and the rotor replaced, but without forcing it. Upon test the same deflection existed as before. To determine if an unbalancing effect existed, the rotor was removed, turned 180 deg. about the shaft, and reseated. This was easily done, as there were four keyways evenly spaced around the shaft. Another test showed the shaft to be only 0.002 in. out of true. The

conclusion was reached that this situation could be remedied by careful dynamic balancing, and a running balance was secured by inserting about two pounds of ¾-in. studs which were screwed in at the top of the rotor frame below the field coils on a radius of about 30 in., as shown in Fig. 2.

The tests for balance were made by running the machine at rated speed, without the governor assembled or

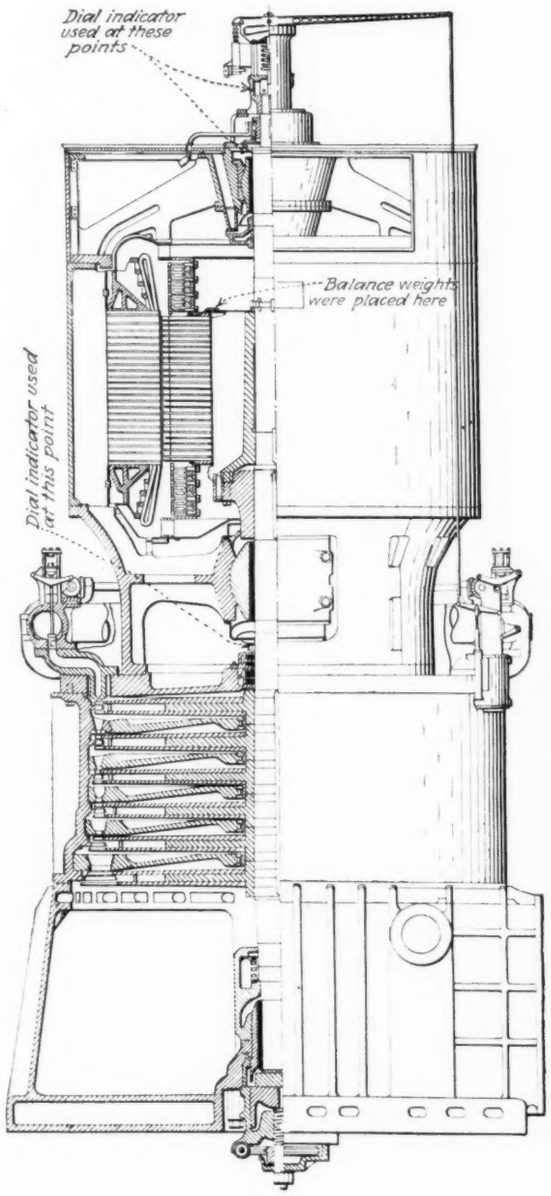


Fig. 2—Sectional view of turbine, showing points where shaft indicator was used and where balance weights were placed

in place, and by chalking the "high" side of the shaft. This operation was repeated until very little vibration was perceptible when one was standing by the side of the machine. Additional checks were made by holding a mechanical vibration indicator on the body of the machine and also on a wooden block held against the shaft.

The turbine was operated without the governor assembled because the governor head is quite large and, being mounted on the upper end of the vertical shaft, could cause leaning or unbalancing of the rotating element in itself. While balancing the rotating element, without the governor, the speed of the turbine was controlled by a hand tachometer held on the upper end of the shaft. In order to use the hand tachometer, it was necessary to thread a piece of 1½-in. bar and screw it in the top of the shaft, the lathe center left in the stud serving as a center for the tachometer point. The speed was regulated by slightly opening or closing the main turbine valve by hand, signals being given by the man with the tachometer on top of the turbine. Should the turbine have approached an excessive speed, the overspeed trip which was mounted on the shaft between the turbine and the generator would have operated and shut the combined automatic stop and main valve almost instantly. No difficulty, however, was encountered in holding the speed at the desired point by hand control.

Stopping the Unit Between Trials

A vertical turbine unit floating on oil under pressure will run for several hours after the steam is shut off. In order, therefore, to stop the unit between balancing trials, the field was excited and the generator voltage brought up to 2,200 volts. The field current should be, say, 80 amperes at full load to give 2,200 volts. It is important not to increase the field current above this amount (the generator voltage falling with the decrease in speed) because of the danger of overheating the field coils. By this method the unit was brought to a stop in about fifteen minutes. The field current was cut off as soon as the unit came to rest to prevent the pitting of the collector rings, which might be caused by current passing from the brushes to the stationary rings.

After the rotating element had been satisfactorily balanced, the governor head was again assembled, each part being tested with a shaft indicator and good alignment secured as the unit revolved. One governor weight was found to be one ounce light, therefore sufficient lead was added to balance the light weight with the heavy one. All knife-edges were examined and were found in good shape. Some lost motion was found in the lever mechanism between the governor and the pilot valve. It was removed by putting in new pins and bushings where necessary, and by inserting shim washers on the sides of the fulcrum of one or two of the levers to take out the side play. The turbine was then put in operation under the governor and the accuracy and regulation of speed checked at no load by a tachometer, covering the range offered by the manipulation of the governor remote control. The overspeed trip was checked for proper operation by means of a tachometer. The regulation of the governor was not changed by the work done on it, and its operation was found to be satisfactory.

Finally, the operation of the turbine was checked from no load to full load. It ran smoothly at all loads without vibration being felt on the pipes and building members. A slow weaving could be felt on the top of the machine, but this was not considered objectionable.

Turbine Vibration—During the past two years the vibration in a number of large turbines has given considerable trouble. This, in some cases, has been traced back to the foundations and the foundation footings having a tendency to vibrate at the same frequency as the turbo-generator. The results of investigations made disclosed the need of a more thorough study of this characteristic of foundations as, at the present time, very little is known on this subject.—*N.E.L.A. Prime Movers Committee Report, 1926-27.*

Live-Steam Reheater for 90,000-Kw. Generating Unit at Crawford Avenue Plant

High-Pressure Steam in Coils to Reheat Turbine Steam Before It Passes to Low-Pressure Cylinder—Will Reheat 500,000 Lb. per Hour to 470 Deg. F.—Operation Inherently Automatic

THE first American installation of a live-steam reheater in connection with a compound turbine will be put into service shortly in Chicago at the Crawford Avenue Station of the Commonwealth Edison Company. This reheater, which will be used in connection with a 90,000-kw. cross-compound turbine, will reheat upward of 500,000 lb. of low-pressure steam per hour. Reheating by live steam is one of those engineering developments that have recently advanced from the stage of ideas to that of accomplished facts.

This method of reheating is of particular interest because it seems to offer a simple and practical solution of one of the difficult problems of insuring dry steam in practically all stages of the turbine. As is well known, the superheat is gradually lost when steam does work by expansion in an efficient steam turbine. The more efficient the turbine the more rapid will be this fall in superheat over any given pressure range. This follows from the fact that greater efficiency means the taking of more energy out of the steam.

It has been demonstrated, at least for large turbines, that practically all of the advantage resulting from the use of high superheat is due to its action in increasing the number of stages in which the steam remains dry. Any given stage of a turbine will operate almost as efficiently with slightly superheated steam as with steam highly superheated. When, however, the expansion continues into the wet region, there is a rapid falling off in efficiency, due chiefly to increased friction and windage.

It seems to be the general consensus of opinion that, for the present, and using ordinary materials in construction, the operating steam temperature should not exceed about 750 deg. F. With the total temperature fixed at this point, or at 725 deg., the increasing of initial pressure merely means starting off with less superheat. There is also a greater range of expansion in which to lose superheat. As a result, the running up of initial pressure beyond about 400 lb. generally results in undue loss of efficiency from wet steam in the lower stages of the turbine, which partly cancels the gain from the higher steam pressure.

This is probably the chief reason why most designers of new stations have kept the pressure below a point where this matter of wet steam becomes serious, while a few others have used higher pressures and compound turbines with provision for reheating the steam between cylinders. The only method of reheating as yet applied commercially in this country in connection with compound turbines involves the use of reheating boilers. These involve a considerable expense for piping and introduce a difficult problem of regulation.

The use of live steam in a reheater placed close to the turbine was proposed by B. N. Broido at the annual meeting of the A.S.M.E., December, 1924. Live-steam reheating has been used to some extent in Europe, but the Crawford Avenue reheater will be the first American installation in connection with a compound turbine.

Since it was started, much pioneer work has been done at Crawford Avenue. The original installation, described in the June 16, 1925, issue of *Power*, was designed to operate at 550 lb. pressure and 725 deg. initial temperature. These conditions have been maintained for units installed or ordered since then.

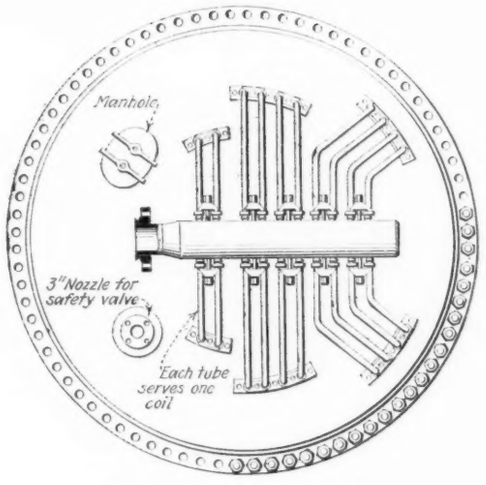
The first three units installed were compound turbines of three different makes. For each of these reheating was accomplished by a special reheating boiler, necessitating the piping of the high-pressure exhaust to the boiler room and back to the turbine room. The fourth unit, installed last year, was also compounded, but with no provision for reheating.

In the spring of 1926 an order was placed for a 90,000-kw. General Electric cross-compound turbine with 35,000 kw. in the high-pressure cylinder and 55,000 kw. in the low-pressure. Somewhat later an order was placed with the Superheater Co. for a coil-type reheater to stand between the cylinders of this turbine and to be operated with live steam. It was specified that, with live steam available at 500 lb. gage and 725 deg., the low-pressure steam should be reheated to 460-480 deg. F., which is equal to or slightly above the saturation temperature of the high-pressure steam.

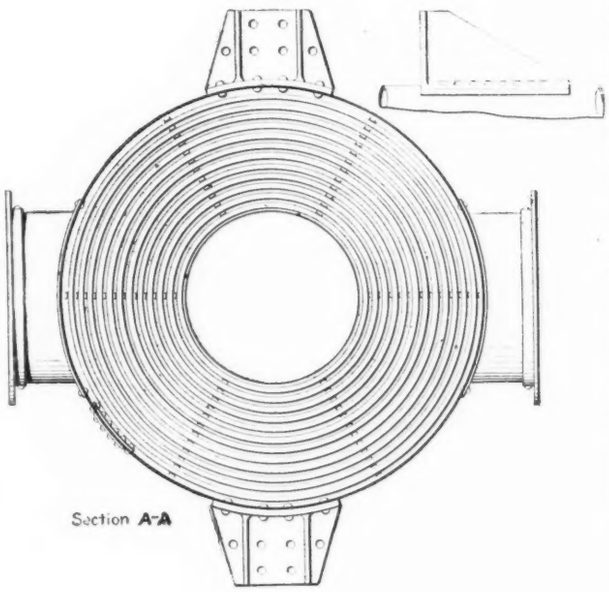
Most of the design features will be made clear by a study of the accompanying drawings. The high-pressure steam passes down through a series of helical coils placed in an annular space through which the low-pressure steam rises before passing down through the central discharge tunnel.

The plan view shows steam-inlet connections for twenty coils, while the cross-section shows only twelve cylindrical layers of coils. The discrepancy is only apparent. Each of the eight outer layers is in fact two coils laid together at the same radius, like the threads on a double-threaded screw. This arrangement largely compensates for the variation in coil radius, permitting the coils to be substantially equal in length so as to operate under about the same steam-velocity conditions.

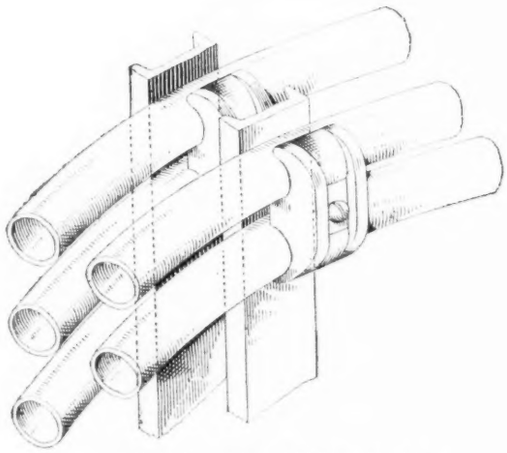
Any layer of coils can be removed without interfering with the other layers. Vertical channel iron spacers are



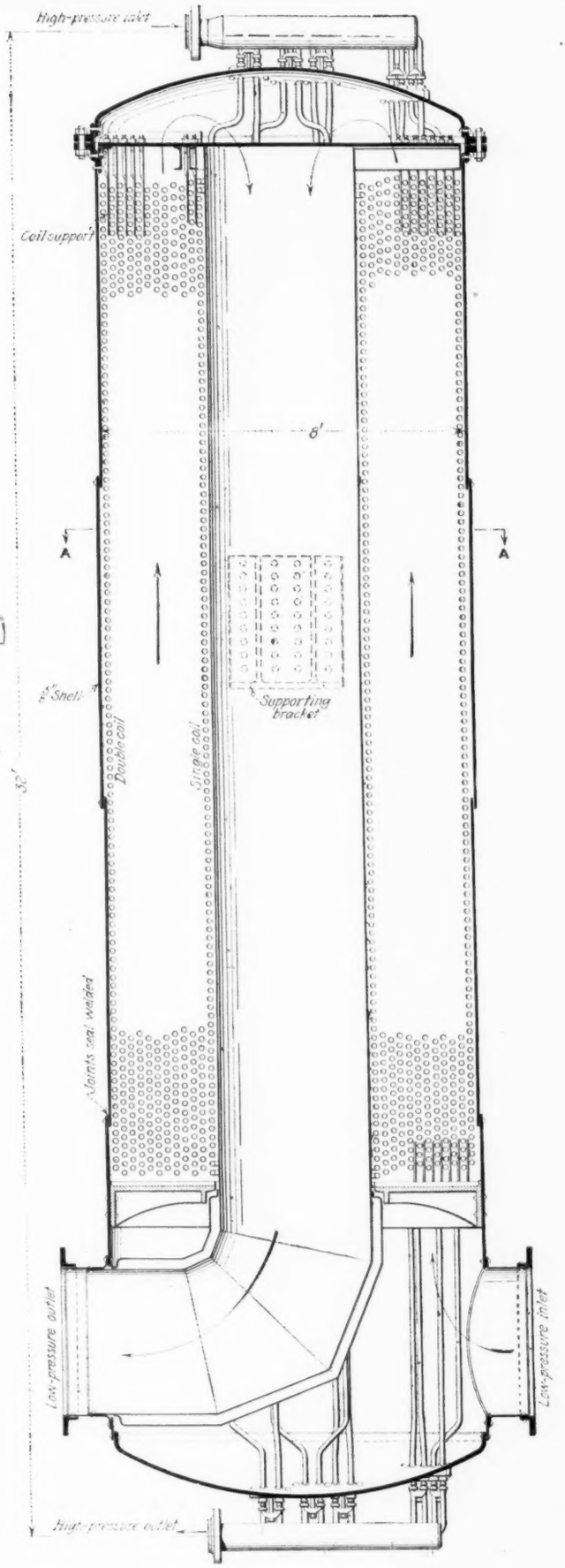
Plan Showing Top of Superheater



Section A-A



Method of Clamping Coil Turns to Uprights



Vertical and horizontal cross section of live-steam reheater to be installed at Crawford Avenue station

arranged along six radial lines, as shown in one of the cross-sections. The isometric sketch shows how the coils are clamped to these spacers, forming a rigid structure which cannot sag out of shape. A small but important detail is the blocking of each clamping screw by the channel iron of the next coil within. Thus it is impossible for any screw to back out, thereby endangering the steam supply for the low-pressure cylinder of the turbine.

It will be noted that the turns of each coil are on a level with the spaces of the adjacent coil. This method of staggering, which is the only one possible without interfering with the coil removal, compels the low-pressure steam to follow a sinuous course in passing up through the coil lanes.

The high-pressure steam enters the top of the coils with full pressure and superheat corresponding to the steam conditions at the turbine throttle. The superheat quickly disappears in the coils, so that the great bulk of the heating is done by the latent heat at the saturation temperature of the 500-lb. steam, which is about 470 deg. With a little aid from the superheat in the high-pressure steam, the reheater is expected to raise the reheated steam temperature slightly above the saturation temperature of the high-pressure steam.

The total heat transmitted by the apparatus will vary but little with the load. At high loads the greater quantity of steam to be reheated will be practically balanced by its higher initial temperature and pressure as it leaves the high-pressure turbine, since under this condition less heat will need to be supplied per pound. It is estimated by the designers that with constant high pressure at the reheater the reheat temperature will not vary more than 10 deg. or thereabouts. The part of the outlet passage which is bathed by the incoming low-temperature steam is made double-walled to reduce heat loss from the heated to the unheated steam. Two inches of 85 per cent magnesia covering will be used on the main shell to reduce heat losses.

The principal dimensions are shown on the drawing. It is worth noting that the height between center lines of high-pressure steam outlet and inlet manifold is 32 ft. The supporting brackets of the reheater will rest on the tops of columns rising from the basement floor to a point slightly higher than the operating floor and between the high-pressure and low-pressure cylinders of the turbine. The location of the brackets is such that less than half of the reheater will project above the operating floor.

As already stated, the first three units installed in the Crawford Avenue Station were provided with special reheat boilers. The fourth unit was not arranged for reheating. The installation of a live-steam reheater on the fifth unit came about from a desire to avoid the expense, control difficulties, and pressure loss that are naturally associated with a fuel-fired reheater in the boiler room.

Such a reheater requires the piping of medium-pressure steam from the high-pressure cylinder of the turbine to the boiler room and back to the low-pressure cylinder. Not only is piping for such pressures excessively large if undue pressure loss is to be avoided, but the reheating boiler must be closely controlled to maintain reasonably constant reheat temperature and to prevent the burning out of reheater tubes when the load is lost.

The live-steam reheater takes its heating steam through a short connection directly from the line supplying the turbine. No outside control is required, as it is obviously impossible to reheat this steam to a temperature much higher than the saturation temperature of the live steam, while appreciable underheating is likewise impossible if the heater has sufficient surface.

The chief argument raised against the live-steam reheater is that the attainable reheat temperature is fairly low, in this case about 470 deg. The designers do not look upon this as a serious drawback, because the steam temperature obtained is sufficient to keep the steam dry in all except the last stage or two of the low-pressure turbine. It is expected that the other advantages of the live-steam heater will more than compensate for the slight loss in efficiency in these last stages.

Generator Refused To Work at Night

By W. J. Bell

AN INVESTIGATION was recently made in the case of a turbine-driven generator that was reported to operate satisfactorily during the day, but would not carry more than half its normal load in the evening hours. The plant superintendent informed the writer that the connections had been checked and the accuracy of the wattmeter tested by the power company's meter

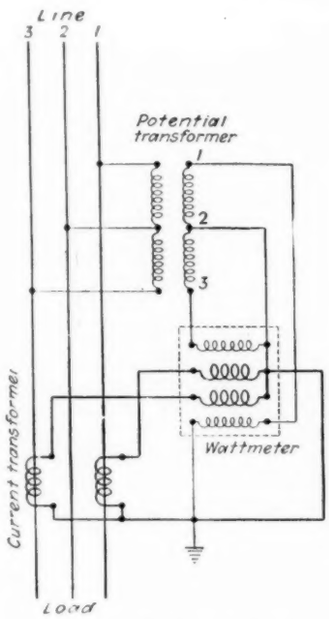


Fig. 1 — Potential coils on wrong phases

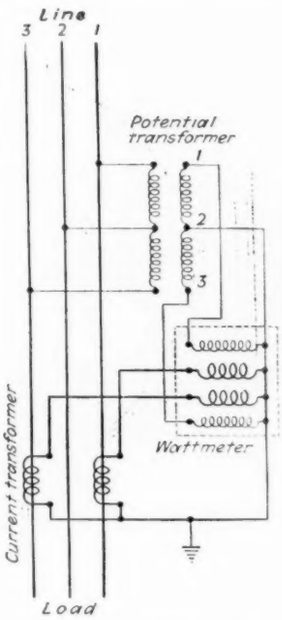


Fig. 2 — Wattmeter correctly connected

experts. They had also tried to increase the pressure at the throttle, but had neglected to test the steam rate of the turbine.

It was discovered that the three-phase wattmeter potential coils had, however, been connected across the wrong phases, as shown in Fig. 1, causing the meter to read in proportion to the wattless component instead of real power. The fault was corrected as shown in Fig. 2, and the meter indicated normal load in the evening as well as during the day.

The power factor of the system was comparatively low during the day on account of a heavy induction-motor load, while the lighting load in the evening resulted in a high power factor. The meter, when reading in proportion to the wattless component, indicated near the value of the real power output in the daytime, but was low at night regardless of real power, as the wattless component was small.

Reciprocating Engine Using 600-Degree Steam Gives Excellent Results

ON FEBRUARY 11, 1926, a cross-compound non-condensing poppet-valve Corliss engine,[1] driving 1,000-kw. direct-current generator at 120 r.p.m. went into operation at the plant of the Dow Chemical Company at Midland, Mich. As this unit had been designed to operate on steam at 686 deg. F., obtained from a pressure of 350 lb. gage and superheat of 250 deg. F., it aroused considerable interest in the power field, particularly in the service it would give under these unusual steam conditions for a reciprocating engine, whether the high steam temperature would create expansion or lubricating difficulties and in the economies that would obtain.

These various points are perhaps best answered by the fact that the engine has been in practically continuous operation for the last 18 months with no forced shutdowns except those caused at rare intervals by the interruption of the process work. Owing to the fact that the boilers were not operated at the rating anticipated, the superheat fell far below that desired, averaging in the vicinity of 150 deg., so that the final temperature

[1] For full details of engine see *Power*, June 15, 1926, pp. 918-21.

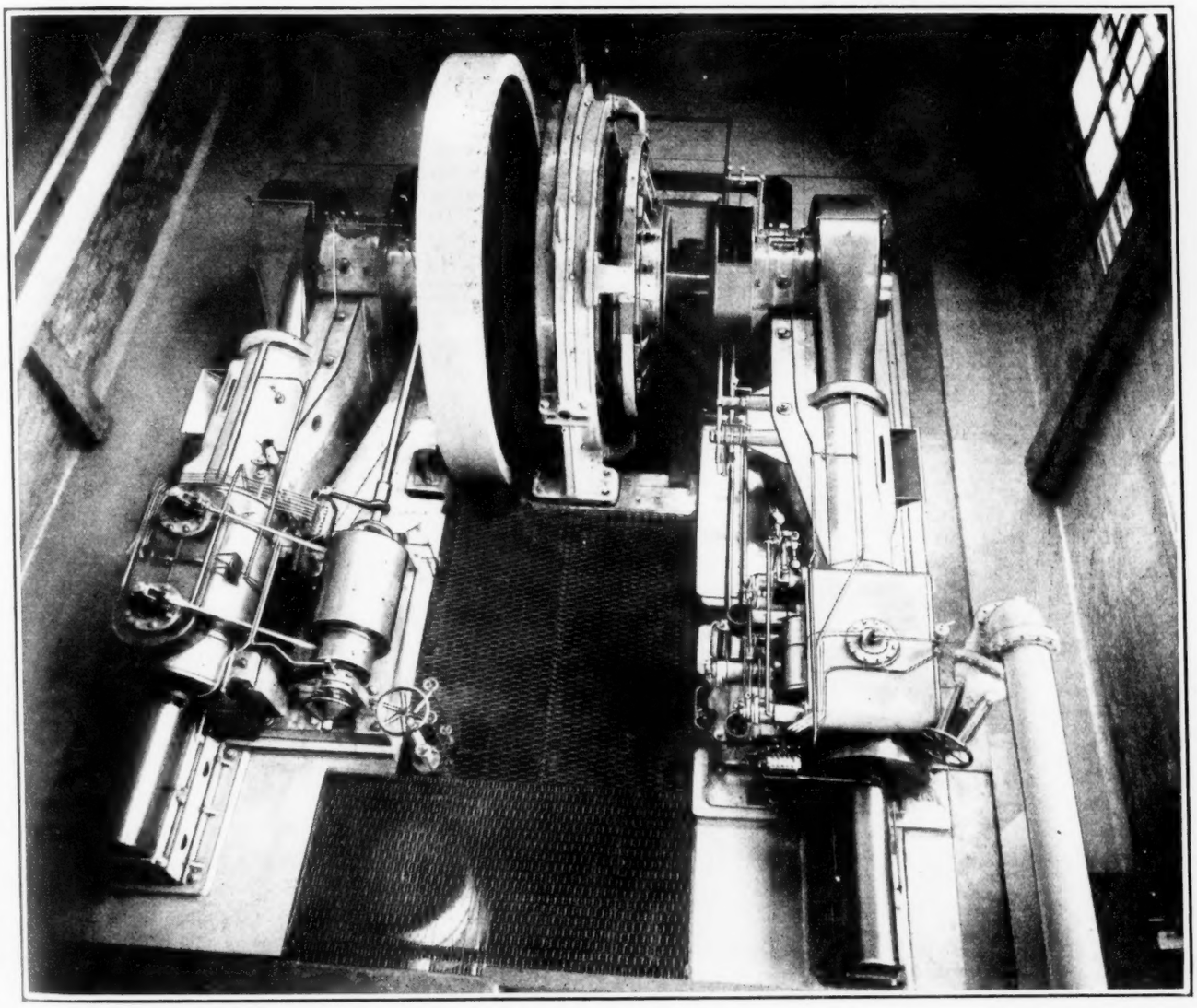


Fig. 1—Cross-compound poppet-valve Corliss engine driving 1,000-kw. generator. Steam conditions, 350 to 420 lb. pressure and a final temperature approximating 600 deg. F.

of the steam did not exceed 600 deg., even though at times the pressure was run up to 380 pounds.

Realizing that in an engine a high degree of superheat does not offer much more advantages, no attempt has been made to raise it, but instead the pressure has been carried up above the original 350 lb., with plans to increase it gradually to 420 lb., giving a final steam temperature close to 600 degrees.

From the previous description of the engine it will be recalled that the high-pressure cylinder was specially designed to prevent heat loss through conduction to other parts of the engine. The cylinder is secured to the bedplate by four supporting feet, one at each corner, so shaped as to give minimum contact. The bottoms of these feet are only 4 in. below the center line of the cylinder, so that the latter is free to expand in either direction without disturbing the alignment.

How well these special provisions are functioning was brought out by observation. Measurements taken with the engine cold and later at normal operating temperature indicated an expansion of $\frac{3}{32}$ in. from the crank end of the cylinder to the supporting foot at the head end, with no change in alignment that could be detected, which was substantiated by no trouble whatever with the metallic packing on the piston rod at either end of the cylinder.

Contact of the high-pressure cylinder with the frame was minimized by the use of distance pieces 13 in. long, which are lined up with large bosses at the side of the cylinder and the frame, so that tie bolts may be used to hold together the two engine parts. Temperatures taken on the high- and low-pressure frames at points 10 in. from the jacket show the results given in Table I. It will be seen that on the high-pressure frame, with an initial steam temperature in the cylinder of 580 deg., the temperature was only 127 deg. F., as compared to 158 deg. F. on the low-pressure frame, with 390-deg. initial steam in the cylinder.

Lubrication of the high-pressure cylinder was another factor requiring special care. To lubricate the piston rings properly, oil was introduced around the center of the cylinder at points spaced 90 deg. apart. As ex-

Operating Data and Test Results

TABLE I—FRAME TEMPERATURES NEAR CYLINDERS

	H. P. Frame Deg. F	Steam Temp., Deg. F.
Point 10 in. from jacket	127	580
Point 36 in. from jacket	104	
	L. P. Frame	
Point 10 in. from jacket	158	390
Point 36 in. from jacket	110	

TABLE II—CONSUMPTION OF CYLINDER AND BEARING OILS

Oil (Ex. Hecla) to h.p. cyl. per 24 hr, qt	1.65
Square feet lubricated per quart	3,660,000
Oil (20th Century) to l.-p. cyl. per 24 hr., qt	3.02
Square feet lubricated per quart	4,250,000
Oil circulated through main bearings, crossheads, etc., gal. per hr.	10.7
Temperature of lubricating oil to engine, deg. F	82
Temperature of lubricating oil from engine, deg. F	97
Surface lubricated per gal. per hr., sq.ft	46,000
Makeup to system per 24 hr. (DTE light), gal	1.21
Surface lubricated per gallon, sq.ft	9,750,000

TABLE III—DATA AND RESULTS FROM ENGINE TEST

1.	Date of test	May 7, 1927	
2.	Location	Midland, Mich.	
3.	Owner	Dow Chemical Co.	
4.	Builder	Nordberg Mfg. Co.	
5.	Test conducted by	H. M. Zoerb, G. H. Wallace and owners observers	
6.	Object of test	To determine steam consumption of engine at full load, over-all efficiency and separate efficiencies of h.-p. and l.-p. cylinders.	
7.	Type of engine	Compound, two-cylinder	
8.	Service	Driving generator.	
9.	Rated power of engine, kw	1,000	
10	Cylinders	High	Low
	Diameter, in	17	32
	Cylinder ratio	1	5.03
11.	Pistons:		
	Diameter, in	17	32
	Stroke, in	30	40
	Effective area, sq.in	207.345	780.492
12.	Clearance vol. in. per cent piston displacement		
	Average both ends, per cent	4.3	3.6
13.	Horsepower constant:		
	Average both ends	0.0157	0.0789
16.	Auxiliaries:		
	Valves, type	Poppet	Corliss
	Governor	Layshaft	
17.	Driven unit:		

Type, Crocker Wheeler, shunt-wound, direct current, interpole, 250 volts. Rating, 1,000 kw. at 120 r.p.m.

Results

19.	Duration of test, hr	3
20.	Average load, kw	1,006
21.	Initial steam pressure, lb. per sq.in., abs	356
22.	Initial steam temperature, deg. F	581
23.	Temp. sat. steam cor. to press. in exh. pipe near engine, deg. F	217.5
24.	Exhaust pressure, lb. per sq.in., abs	16.43
25.	Steam rate per i.-hp.-hr., lb	12.8
29.	Thermal eff. (ref. to i.-hp.) per cent	17.83
30.	Engine eff. over-all (refer to Rankine cycle) per cent	79.4
	H-p. cyl. eff. (ref. to Rankine cycle) per cent	76.8
	L-p. cyl. eff. (ref. to Rankine cycle) per cent	82.4

Supporting Data

31.	Barometric pressure . . . 29.4 in. Hg. . . . 14.43 lb. per sq.in.	
32.	Pressure in steam pipe near throttle, lb. gage	354
	Corresponding abs. pressure	368.4
	Min. abs. pressure above atmos. diagram	354.4
33.	Pressure in receiver, lb. gage	70.7
	Corresponding abs. pressure	85.1
35.	Pressure in exhaust pipe, lb. abs	16.4

Temperatures

38.	Temp. steam near throttle, deg. F	581
39.	Temp. sat. steam at throttle press, deg. F	436.7
40.	Temp. steam entering reheater, deg. F	324.8
	Degrees superheat	8.5
	Temp. steam leaving reheater, deg. F	390
	Degrees superheat	73.5
42.	Temp. sat. steam at exh. press., deg. F	217.5
43.	Temp. exh. steam as observed, deg. F	219.5
44.	Superheat of steam at throttle, deg. F	144.3

Total Steam Quantities

46.	Main condensate, lb	55,000
	Exhaust-line condensate, lb	2,030
	Reheater and jacket condensate, lb	2,583
	Total condensate, lb	59,613

Hourly Quantities

50.	Total steam per hr., all purposes, lb	19,868
	Main condensate, lb	18,330
	Exhaust line, lb	677
	Per cent of total	3.4
	Reheater condensate, lb	861
	Per cent of total	4.33

Heat Consumption

53.	Heat content per lb. steam at throttle, B.t.u	1,298
54.	Heat content of liquid at exh. press., B.t.u	182.2
55.	Heat supplied per lb. of steam, B.t.u	1,115.8
56.	Heat consumed per hour, B.t.u	22,140,000
57.	Net work per lb. available in ideal engine operating on Rankine cycle, B.t.u	250

Indicator Diagrams

		H.P.	L.P.
58.	Nominal cutoff, av. per cent	53	39.3
59.	Mean eff. press., av	203.38	42.14
	Referred to low pressure	40.2	42.14

Speed

62.	Revolutions per minute	119
	Variations of speed between no load and full load, per cent	4.1
63.	Piston speed h.-p., ft. per min	595
	Piston speed, l.-p., ft. per min	794

Power

64.	I.-hp. of h.-p. cyl., both ends	759
65.	I.hp. of l.-p. cyl., both ends	791
67.	Total i.hp.	1,550
71.	I.hp. at no load	57.2
72.	Mech. eff. from cards, per cent	96.3

Economy Results

73.	Steam rate per i.hp.-hr., lb	12.8
79.	Heat rate per i.hp.-hr., B.t.u	14,280
80.	Heat available according to Rankine cycle per i.hp.-hr. B.t.u.	3,200

Efficiency Results

83.	Thermal eff. (ref. to i.hp.) per cent	17.83
85.	Engine eff. (Rankine cycle) based on i.hp., per cent	79.4

Electrical Data

89.	Average volts	252
90.	Average amperes	3,900
92.	Total output, kw	3,020
	Kw. per hour	1,006.6

Power and Economy

94.	Electrical hp. developed	1,350
95.	Steam rate per kw.-hr., lb	19.75
98.	Heat rate per kw.-hr., B.t.u	22,000

Note: Figures in left hand column of table refer to A.S.M.E. test code of 1926 for reciprocating steam engines.

plained in the original description, these four supply ports have been introduced in addition to the regular feeds—that is, one in each steam valve chest above the poppet valves and one in each piston-rod packing case—so that the high-pressure cylinder has eight feeds from the lubricating pump, which is of the plunger type with eight adjustments and driven from the shaft by an eccentric. The quantities of oil required for cylinder and bearing lubrication are given in Table II. The figures are based on operating reports for March and April, 1927, during which period the unit was in continuous operation.

To determine the steam consumption of the engine at full load, as well as the over-all efficiency and separate efficiencies of the high- and low-pressure cylinders, a three-hour test was conducted on May 7, with the engine operating at full load, in accordance with the A. S. M. E. Code of 1926 for reciprocating steam engines. Full operating data and results are given in Table III.

In service the unit exhausts into evaporating pans which are part of the process of the plant, thereby reclaiming some of the heat in the exhaust steam. For the test the regular exhaust line of the engine was blanked off and the exhaust directed into a nearby evaporating pan, ordinarily used as an exhaust for a turbine operating in the same engine room.

Immediately after leaving the engine, the exhaust was passed through a receiver, acting in this case as a separator trapping out the water present, which, with the exception of some radiation loss, is an approximate measure of the quality of the steam as under the exhaust conditions. The main condensate, after leaving the evaporating pan, was piped by gravity into calibrated measuring tanks. Condensate from the high-pressure jacket and the reheater system was trapped off through a single trap and passed through a set of coils before going to the scales, the use of the coils being necessitated as the trap was of the bucket type and caused considerable turbulence from dumping.

Steam conditions were measured by a thermometer at the inlet valve and checked by means of a thermometer on the superheater outlet. Pressure was taken at the inlet valve and checked by the gage on the main receiver. On the low-pressure cylinder the back pressure was measured by a mercury gage. It was necessary, however, to have a rubber tube connecting the pipe and the gage with approximately a 6-ft. head on the gage. Readings taken on a thermometer at the same point and those on the mercury gage did not agree, indicating that some water was present in the connections to the mercury gage, so that in the results given in the table a correction has been made for this head.

The electrical load was measured by means of voltmeters, ammeters and an integrating wattmeter. The readings of the wattmeter were taken as being the more accurate, owing to the fact that any slight fluctuations in load would be recorded. Readings were taken every 10 minutes and indicator diagrams every 15 minutes.

Results obtained on the over-all economy of the unit are considered especially accurate, as the amount of working steam was measured as carefully as possible. In general, the test shows unusually high economy for this type of unit, as indicated by a steam rate per indicated horsepower - hour of 12.8 lb., a thermal efficiency (referred to i.h.p.) of 17.83 per cent, a high-pressure cylinder efficiency of 76.8 per cent, a low-pressure cylinder efficiency of 82.4 per cent, and an over-all engine efficiency (referred to the Rankine cycle) of 79.4 per cent. The steam rate figured 19 75 lb. per kilowatt-hour, indicating a heat consumption of 22,000 B.t.u. From the diagram the mechanical efficiency figured 96.3 per cent. It will be noticed from the test data that those results were accomplished with the engine working against a back pressure of 16.43 lb. absolute or approximately 2 lb. gage.

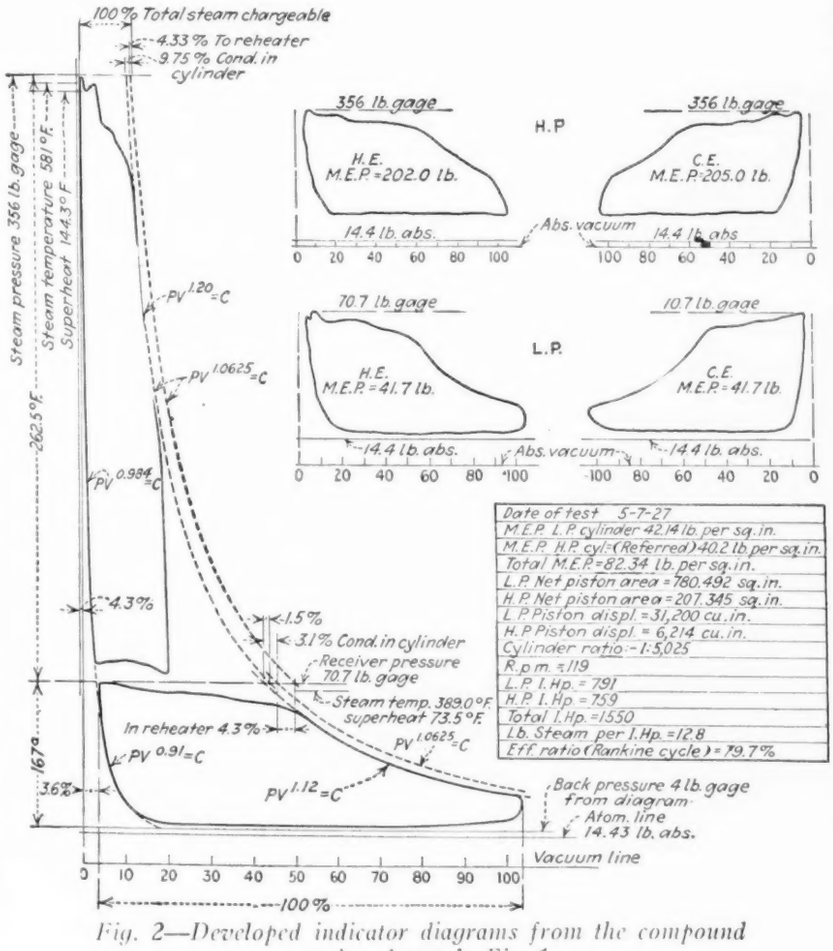


Fig. 2—Developed indicator diagrams from the compound engine shown in Fig. 1

From the developed indicator diagram in Fig. 2 apparently the expansion loss in the high-pressure cylinder is high, but this is offset by the high quality of the steam available for the low-pressure cylinder, for, as shown in Table III. the steam entering the reheater is superheated 8.5 deg. This of course, is a question of cylinder ratios. It is quite likely that better diagrams would have been obtained with the engine operating between three-quarters and full load.

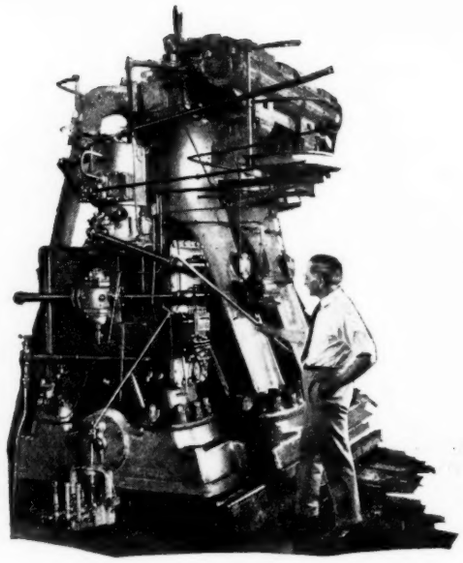
Remember

The Compressor

Warns an Engineer

By A. B. Newell

Suggestions on the Overhauling of Diesel Compressors—When and How To Clean Coils—Cause of Carbon Deposits



ABOUT the most important lesson that experience in the operation of Diesel and oil engines has taught and perhaps the greatest contribution to the present-day success of this type of machinery, has been the necessity of schedule methods of overhauling. The importance of employing such methods does not end with their application to the engine alone if we are to consider the air compressor as an accessory.

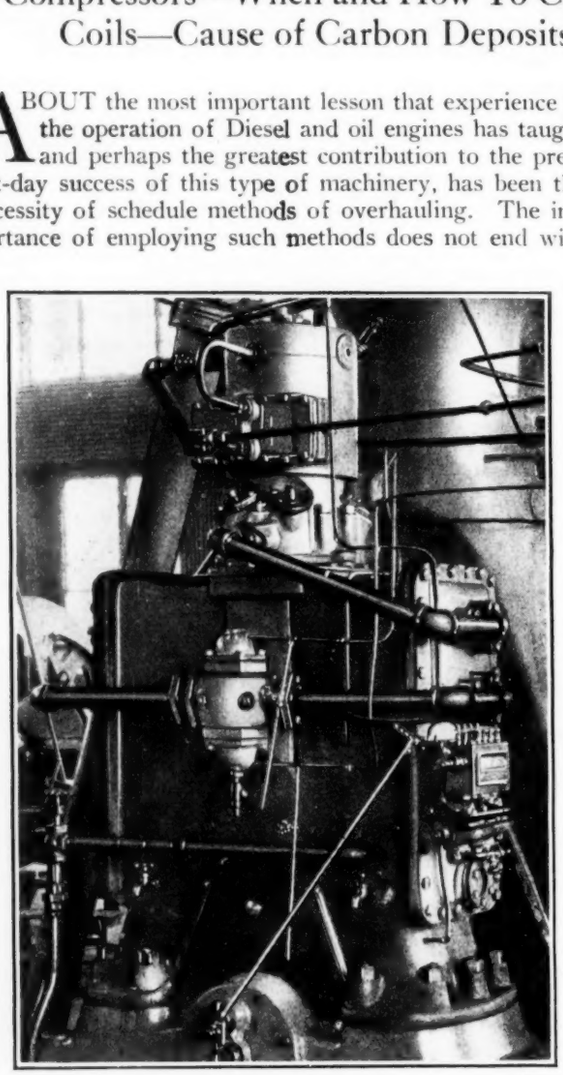


Fig. 1—A typical compressor and intercoolers

The compressor should receive a general overhauling annually and a partial overhauling at regular intervals. This does not mean that the parts that are to receive attention will be found in bad condition. On the contrary they are generally found to be in good shape, and such work as may be done is merely a method of insuring a continuation of this condition.

The annual overhaul generally consists of the removal of pistons, survey of rings and cylinder liners, examination of top and bottom end bearings and the necessary adjustments. The air pipes should also be removed and cleared of carbon, and the oil should be steamed out of the air receivers and bottles. It is seldom necessary and not always advisable to remove the cooling coils, but the water space around them should be cleared of mud and sediment if they have accumulated. However, when the coils are old—that is, after seeing three or four years of service—the copper may become thin in spots, and when this condition is suspected it is advisable to place them under hydrostatic test of about twice their maximum working pressure.

While the water jackets should be cleared of sediment at this time, it is not advisable to place them under hydrostatic test, because there is danger of breaking the cast iron, which would otherwise be serviceable for a number of years. No danger exists even if leaks develop in these castings during operation, such as does exist while operating with weakened cooling coils.

Expense of Overhaul Seldom Great

The work and expense of the annual overhaul of the compressor is seldom great and there can be no justification of carelessness. For example, if any of the bearings has been renewed or if any of them shows indications of excessive wear, or if the piston-to-head clearance is not known, pieces of lead wire should be crushed between the cylinder heads and pistons by turning the crank past both top and bottom centers with the complete assembly made. The leads will indicate the clearance which, if wrong, may be corrected by placing a shim between the crank box and the foot of the connecting rod or removing one, as the case may require.

All old gaskets should be renewed unless they are solid copper, which, if in good condition, should be annealed. The over-pressure relief valves should receive especial

attention in the form of a test of the spring, cleaning and grinding.

It will be found necessary to do a certain amount of cleaning, and kerosene will probably be employed, in which event every bit of it should be carefully removed from the interior working parts, for its presence within the compressor during compression may cause a bad explosion.

It is reasonable to suppose that at the end of the first year of operation the rings and cylinder liners will be

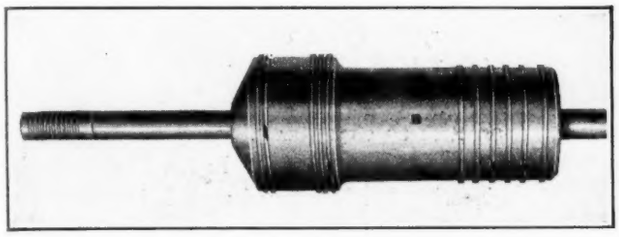


Fig. 2—Three-stage compressor piston

found in good condition. The most wear will occur on the high-pressure stage, and while the rings of this may appear to be in excellent shape when first removed, it seldom pays to attempt to get two years of continuous service out of them. The intermediate- and low-pressure rings last much longer, and as long as they appear to be in good condition their renewal is not justified; they sometimes last four or five years.

If the rings show but slight indication of wear, there is no need of checking the cylinder dimensions, for rings will never outlast the liners if made of the right material. It is common to find indications of tool marking within the cylinders for several years after they go into service.

Overhauling Reveals Faulty Conditions

If faulty conditions of operation exist, they will often be revealed during the overhaul. Heavy carbon deposits within the delivery pipes indicate excessive lubrication. A filthy condition of the first-stage piston head indicates that the compressor is taking in dirty air, while a streaked and fuzzy appearance of any of the liners shows a lack of lubrication and will commonly be found with badly worn rings.

Deposits of carbon within any of the pipes may be removed by heating them to a dark red and then letting them cool slowly, after which the carbon may be jarred free by tapping the pipe with a soft hammer.

Overhaul of the air-compressor valves cannot be considered to be a part of the annual overhaul, although they are generally taken care of at that time. They demand considerably more attention than any other part of the compressor. The high-pressure valves should be removed and examined every two weeks if possible, and it is not advisable to let them run more than a month, although it is sometimes done. There is one general rule that applies to the overhaul of all compressor valves. They should be made perfectly clean, the lift should never be changed, they should work freely when assembled and be put back on a gasket that is tight.

Various methods are employed with various types of valves. Some are ground upon their seats, some are brought to a true face by lapping on a faceplate. Some are so designed that reconditioning is not possible and not expected and, once they become in bad shape, they are discarded. These latter are the disk and strip types, so designed that their construction is cheap and their renewal, when necessary, is but a small item of expense. Sharp instruments should not be employed when working on these valves, for the seats may be marred, causing them to leak.

It should be remembered that a leaking gasket seat under a valve cage will give about the same symptom of unsatisfactory operation that a leaking valve does, and for this reason every precaution should be taken to prevent leakage by the cage.

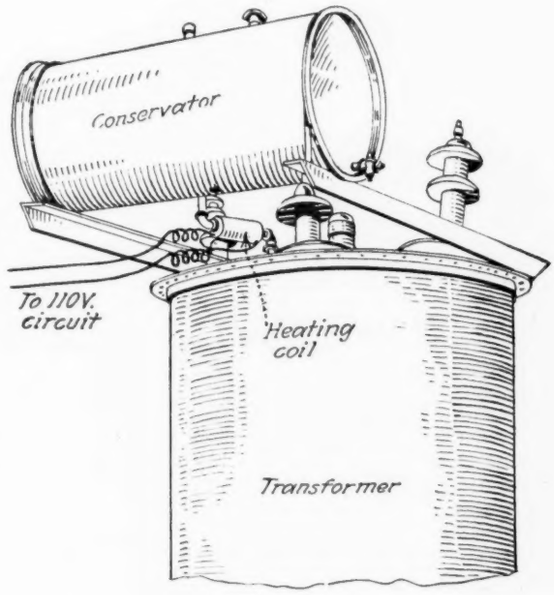
While the intermediate- and low-pressure valves may not require attention every month, as do the high-pressure ones, it is best to give them such attention if possible; but in all events the delivery valves should receive more attention than the suction valves, for the latter operate at a much lower temperature and do not carbonize.

Protecting Transformer Conservator Connections in Cold Weather

By E. J. Merrissey

A CONSERVATOR tank is placed on a large transformer to provide space for expansion of the oil. It also protects the oil from the air, preventing blackening due to oxidation.

The conservator tank is mounted above the transformer case, as indicated in the figure, and is normally connected to it by a small pipe. When the transformer



Heating coil warms connection from conservator to transformer

is out of service in cold weather, oil congeals in this pipe. In the event it is then put on the line, the expanding oil cannot pass freely to the conservator tank and will force its way out through the cover gasket.

The illustration shows a practical remedy that has been applied by placing around this pipe a strip heating unit, incased in asbestos and connected to a 110-volt lighting circuit. The oil in the pipe is thus heated at the same time the transformer is put on the line, and no further trouble has developed.

EDITORIALS

F. R. LOW, *Editor*

Insuring Power Service

THE New York Edison Company has completed the laying of a one hundred and thirty-two kilovolt underground transmission line from its Hell Gate station to a connection with the Westchester County system. This expensive step should effectually safeguard against line disturbances and probably is the forerunner of numerous other underground lines.

In the past most of the endeavor of generating companies has been to insure the continuity of service at the power house, and the advances have been such that it is rare to learn of a plant's being shut down on account of machine trouble. The same cannot be said for the outside lines, and the chief objection raised among users of purchased current has been the frequency of shutdown or partial shutdown due to line disturbances. Underground lines would eliminate much of this and, while costly, must be used if service is to be assured.

In a recent visit to an industrial district where power is supplied by several large systems, a *Power* editor found that each industrial plant visited was having or had been having trouble due to line disturbances. In one case the mill carried part of its load with its own power house and was confronted with so much disturbance that its own engines were frequently overloaded. To reduce this, it was necessary to arrange a voltage control so that as the line voltage dropped, that of the engine-generators was also reduced. This, however, while safeguarding the engines, did not enable the mill to maintain its output. The mill owner at present has no way by which he may recover his losses. Use-and-occupancy insurance covers only breakdowns of some duration and ignores momentary line disturbances, although these may damage goods in process almost as extensively as if the shutdown were complete.

Regularity of service is essential to any industry and eventually, either underground lines, duplicate service lines or stand-by power plants must be used.

The Consulting Engineer

A FEW years ago it was the ambition of nearly every young engineer to establish himself as a consulting engineer as soon as he had sufficiently mastered the principles of his profession and their application to practical problems. This laudable ambition had much to do with the rapid development of many lines of engineering, for a man thrown upon his own resources must render satisfactory service to his clients or he loses his business.

The same types of young men are leaving our colleges, and some still strive to become consulting engineers. However, the status of the consulting engineer has changed and is still changing, so that there is less opportunity than formerly for the younger men to develop a practice as consultants.

Several influences are at work. In the first place the field of engineering has broadened until it is almost impossible for any one engineer to be competent to work in every branch of the field. Hence there is a tendency to specialize.

There is also a tendency toward standardization in manufacture whereby the builders of machinery develop certain sizes and types which are offered on the market. They employ many highly skilled engineers on this work alone. There is also the further tendency of buyers to rely on these manufacturing concerns for advice and assistance in planning installations. There is even a trend on the part of large concerns to take over the whole design, installation and operation of the proposed plant.

For instance, many large electrical operating concerns have provided organizations to care for the design of their new power plants and additions to old ones, in place of calling in consulting engineers.

This naturally narrows the field of the consulting engineer, who now must generally be a specialist in one particular line and who is called in frequently to pass on the work of others. The young engineer now generally seeks employment with manufacturers or power producers. It will be interesting to watch whether consulting engineering will continue an attractive profession or whether this work will be taken over entirely by the larger organizations.

Efficiency and Economy

THE difference between efficiency and economy should be thoroughly understood by everyone who has anything to do with the management of a power plant. Many times, the difference in dollars between efficiency and economy is not entirely appreciated as a practical proposition.

Although, generally, increased efficiency means increased economy, there are many cases in which efforts to increase efficiency have resulted in a decrease in economy. Such was the case in a certain mill having a fairly large and good, although not entirely modern power plant. The

superintendent was not satisfied with the output or the efficiencies of the furnaces and boilers and decided upon a campaign to increase both the output and the efficiency. This was accomplished with the help of the boiler-room force, and the superintendent was immensely pleased with the new plan of operation. However, within a relatively short time the grates began to burn out, and one day an arch dropped, although it had been in service but a comparatively short time.

The superintendent had a good lesson in the difference between economy and efficiency. Although under his new method of operation the efficiency and capacity had been increased, the maintenance and upkeep cost of the equipment had mounted altogether out of proportion to the advantage of the increase in efficiency and capacity. There is a point in the operation of a plant beyond which the capacity or efficiency cannot be pushed without a serious reduction in the plant economy. It is good management to determine this condition and to operate accordingly.

Quite frequently, the advantage of increased efficiency obtained by changing or adding equipment in an existing plant, is more than overcome by the expense of the capital charge incurred in bringing about the increase. The same situation may also exist in stand-by plants where increased efficiency for the short periods of operation does not justify the capital outlay necessary to make higher efficiencies possible.

The practical dollar-and-cents difference between efficiency and economy should be kept in mind.

Can Noise Be Eliminated?

THE estimate recently made that the production of noise is costing the City of Chicago in excess of five million dollars a year, brings to the attention of engineers and industrial leaders a matter that calls for some study and action.

It is now known that noise has a pronounced effect upon the fatigue of human beings and upon the accuracy and speed at which they work. In fact, noise is responsible for much of the inefficiency and waste. And yet little or nothing has been done to prevent or reduce it.

In the past the production of noise has generally been taken as evidence of great industrial activity, in much the same way that a chimney belching out black smoke indicated the general prosperity of the plant or industry. But as smoke is now known as a great economic waste, so noise will some day be placed under the ban and industrial leaders and engineers will make efforts to reduce or prevent it.

Much progress has been made in the reduction of noise in our offices and clerical departments. One who is fortunate enough to have worked in the vicinity of a battery of noiseless typewriters, would never think of going back to try to work in competition with the noise and racket of the old type of writing machine. Why would not a similar reduction of noise have the same advantages in our power plants and industries in general?

There are many power plants in which there is so much noise that even conversation is possible only on the outside of the plant. The noise and hum of turbines, gears, pumps, compressors, gas engines, etc., is commonplace and in some plants is next to unbearable. And we expect people to work under these conditions which, we are told, are responsible for much of the reduced efficiency and increased depreciation of our human equipment.

Engineers who have studied the situation tell us that it is possible to reduce much of the noise now produced. When will those responsible for the design, installation and operation of our machinery put noise reduction on a practical basis?

Some day noise reduction will be accomplished in engineering and industry.

Automatic Control Pays

HUMAN error has always been a significant item in decreasing the efficiency and reliability of plant operation. Automatic control is replacing manual operation, however, and when it is not practical to install complete automatic control, remote control of a large amount of equipment may be accomplished from a central location.

Improvements resulting from automatic control equipment may be classed as intangible and real. In case of an accident or breakdown of a piece of machinery, accurate and speedy automatic control in the plant may greatly reduce the hazard to life and physical property and the interruption to service. The profit accruing from these benefits cannot be accurately estimated as a rule, although some power contracts carry a penalty for interruption of service. Increased safety to life and property may be regarded as good insurance.

With few exceptions the more accurate and better co-ordinated results of automatic control will raise the efficiency of a plant. Operations are performed the instant the controlling device is affected; therefore, better regulation is obtained than when it is necessary for the incorrect condition to be noticeable to a man before the need of adjustment is apparent. Results are thus more consistent and more accurately predetermined; and labor is saved.

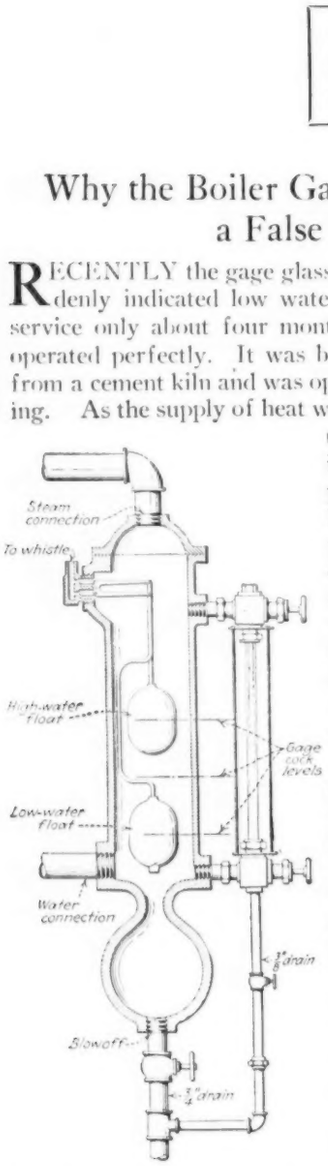
The justifiable investment in such equipment depends upon individual conditions and the type of service required. Large central stations in which continuity of service is paramount are probably furthest advanced in the use of automatic control. Particularly in designing new plants, however, in which suitable conditions may be provided, the cost of the equipment should be weighed against the real saving and the tangible improvements. Automatic control will usually be found a sound investment.

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Why the Boiler Gage Glass Showed a False Level

RECENTLY the gage glass on a water-tube boiler suddenly indicated low water. The boiler had been in service only about four months and until this time had operated perfectly. It was being fired with waste gases from a cement kiln and was operating at about normal rating. As the supply of heat was fairly constant, there was no reason for wide variation in the water level. The supply lines, being new, were known to be clean and the position of the valve arm on the feed-water regulator showed a partly open feed valve. On other similar boilers with the regulators in the same position the water appeared in the middle of the gage glass.



Leaky valve in gage-glass drain line caused glass to show false water level

The water column was equipped with a single alarm whistle operated by both high- and low-water floats, and the whistle continued to blow, so that the natural conclusion was that the boiler did not have sufficient water. It was immediately taken off the line, but the feed-water valve was not closed and shortly water appeared at the whistle. Still no water appeared in the gage glass. At this time the feed-water valve was closed and the boiler allowed to cool down. When it had cooled down until the gage pressure indicated 50 lb., the water again appeared in the gage glass, and as the pressure reduced on the boiler, the height of the water in the glass increased.

After the boiler had cooled down, both the steam and water connections to the water column and also the gage glass connections were examined and found perfectly clear. The boiler was again filled with water and the top removed from the water column and the water level in the gage was checked against the level in the water column and found to correspond. The top was placed back on the column and the boiler again brought up to full pressure. As the pressure on the boiler increased, the water level in the gage glass decreased, whereas in ordinary practice the water level should increase as the pressure increases and continue to increase until the boiler is actually delivering steam to the line. The try-cocks on the side of the water column indicated that the water level was actually rising while the water level in the gage was going down. When the water showed in the top try-cock and was appearing just below the bottom one, as judged from gage glass, the alarm whistle began to blow. We naturally concluded the water was low, while actually, as we discovered later, it was blowing from high water. Again the feed valve was opened, and shortly water appeared at the whistle. Still no water was apparent in the gage glass.

When the boiler was originally piped up, the ¾-in drain from the water column and the ⅜-in. drain from the gage glass were connected just beyond the valves and then continued on to the sewer. This undoubtedly made a good appearance but was misleading. While we were endeavoring to locate the trouble, both these valves were opened and closed a number of times and naturally the pipes were hot to the hand, so that the fact that the pipes were hot was not taken as an indication of trouble.

The cause of the trouble was finally discovered when the two drains were disconnected and it was seen that the ⅜-in. drain line from the gage glass was leaking badly. In fact it was leaking so much that the opening in the connection to the gage glass was not large enough to furnish sufficient water to supply the leaking valve and at the same time keep a normal level in the gage glass. However, the connections between the boiler and the water column were large enough to supply the leak and therefore were maintaining the correct level in the column. As soon as the ⅜-in. valve was repaired, the water appeared at the proper level in the gage glass.

It, unquestionably, would be dangerous to allow drains of this kind to discharge to the open. Still, if some arrangement could be devised so that the discharge from each drain could be observed with safety a number of delays could be avoided. The actual loss from a leak of this kind would more than offset the expense incurred in making suitable pipe connections.

Nazareth, Pa. ERNEST M. AYRES.

Using Turbine-Driven Generator as Synchronous Condenser

THE use of generating equipment to carry wattless current is common practice, but the personnel of some isolated stations or industrial plants may not be fully aware of the advantages to be obtained thereby. This mode of operation is resorted to where low-efficiency

turbines are part of the plant equipment or are connected to the system electrically.

Probably the best explanation can be given by relating a situation recently brought to the writer's attention. A completely isolated industrial plant supplying a load of 5,100 kw. was carrying the total load on two 2,000-kw. generators. The system power factor was 80 per cent, and the power-factor rating of the two 2,000-kw. generators and an older 1,000-kw. machine was likewise 80 per cent. This combination gave the generating station a rating of 6,250 kva., while the load amounted to 6,375 kilovolt-amperes.

The old 1,000-kw. generator was used only in emergency because of its high steam rate. When supplying the total load at 80 per cent power factor, the two larger generators were overloaded 28 per cent. At unity power factor their rating would have been exceeded by only 100 kva., or 2 per cent.

The logical procedure under the circumstances was to reduce the overload on the two larger and more economical generators, thereby lowering their operating temperatures and the hazard of failure. This was done by carrying the wattless current on the older 1,000-kw. generator; its field was overexcited and it was operated as a synchronous condenser.

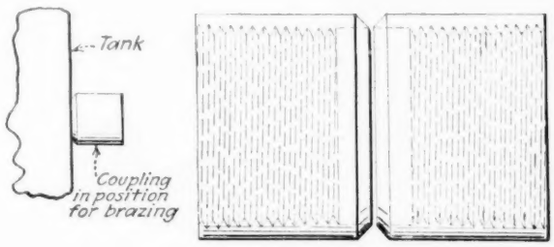
No change needed to be made in the 1,000-kw. unit for such use. Accordingly, it has always been available for emergency service and to carry peak loads. The unit is brought up to speed and synchronized in the usual manner, and the steam valve is then closed so that just sufficient steam is passed to prevent the turbine blading from overheating because of windage. By controlling the field of the generator, which is acting as a synchronous condenser, the power factor of the station can be corrected to any desired value, provided the safe operating temperature of the field is not exceeded.

In cases where the generating capacity of such an old turbine-driven generator is not needed for stand-by use, it will often be found more economical to scrap it and buy a synchronous condenser of modern design, as the efficiency of the latter is high and will result in a considerable saving in energy.

F. W. Evans,
New York City. Westinghouse Elec. & Mfg. Co.

An Inexpensive Method of Adding Pipe Flanges to Tanks or Receivers in Service

In A plant having several welded-iron condensate receivers, it became necessary several times to provide for additional trap discharge connections on short notice and the time could not be taken to remove the receivers from service to perform a good welding job. As this plant was in a small town where regular tank welding flanges could not be obtained, it was necessary to resort to "home-made" ones. These were quickly produced in sizes varying from 1- to 2½-in. standard pipe sizes by cutting in halves in a lathe an ordinary pipe coupling, a suitable bevel being put on the end to be joined after the cutting operation so as to allow the spelter to flow well under the piece. After laying out the proper location on the receiver, which in some cases came on the side of the tank as well as on the top, the welding operator proceeded to braze on the half-coupling, using a Tobin bronze brazing rod and Smith's Amalgum for a flux. It would be a difficult job to weld a flange on the side of a tank, yet this was done repeatedly by the brazing process and with a steam-tight joint always assured. After the coupling had been brazed on in each case, the handhole cover was removed, a bucket or basin was put inside the tank to catch the burnt metal, and the hole into the tank from the coupling was readily cut with a cutting tip of the welding torch, the coupling guiding the tip to cut a perfect circle. By proper handling of the cutting



Pipe connection to tank made by cutting standard pipe coupling in halves

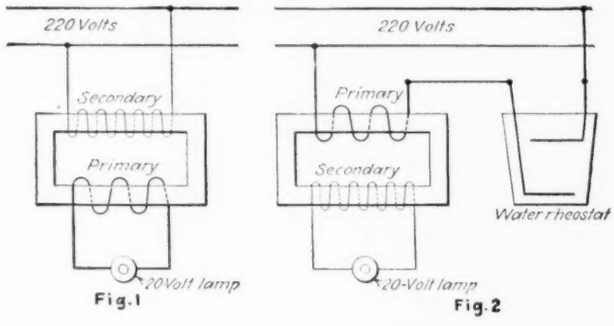
torch, the threads were not damaged in the least, and as soon as the basin of burnt metal was removed from the inside of the receiver and the handhole cover put on, the new tank inlet was ready to be connected to the additional trap discharge and the receiver put back into service again.

Newark, N. J. P. T. Van Bibber.

Current Transformer Supplies 20-Volt Lamp

In OUR plant 220 volts is used for lighting. To prevent danger from this voltage when using a light to inspect the inside of the steam boilers a 220- to 20-volt transformer is used. From this transformer a line is run for the 20-volt lamps used when working on the boiler.

On one occasion when urgent boiler repairs were necessary this transformer was burned out and no spare was available. To supply the emergency a 50- to 5-ampere current transformer was connected as in the diagram, Fig. 1. In this connection the secondary of the transformer is connected to the 220-volt line and what was originally the primary winding is connected to



Two methods of supplying a 20-volt lamp with a current transformer

the lamp. This arrangement worked out very well and gave a satisfactory voltage for lighting the 20-volt lamp.

Although it was not tried, another way of using the current transformer would be to connect a water rheostat

in series with the primary and the lamp to the secondary, as in Fig. 2, and adjust the rheostat until the proper voltage for operating the lamp is obtained. A possible objection to this last method, however, is that the workman might be exposed to a dangerous voltage in case the load should be taken off, as by breaking of the lamp or a loose connection in the socket.

Moskow, U. of S. R. R. GEORGE RICHTER.

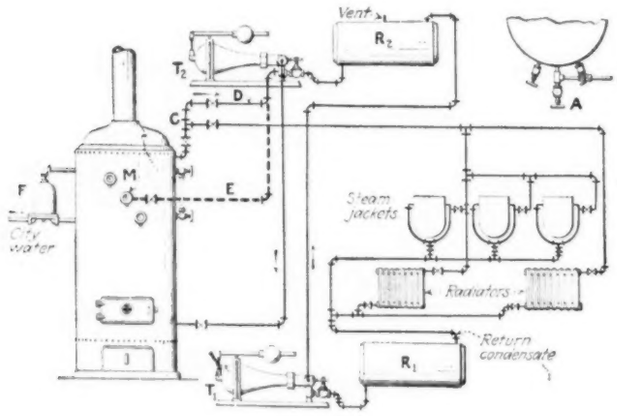
How the Boiler Feed by Means of Traps Was Made Automatic

On a return-trap system feeding the condensate back to the boiler we encountered difficulty in maintaining the water level manually. The boiler would continually flood, and at the same time it used considerable city water. It was a small vertical gas-fired boiler, supplying steam to some steam-jacketed kettles and heating radiators. We finally hit upon a plan that rendered the system automatic.

The original layout and the changes made in the connections are shown in the illustration. The condensate from the kettles and radiators drained by gravity to the receiver R_1, from which it was lifted to receiver R_2 by means of the tilt trap T_1. When the upper receiver and tilt trap T_2 became filled with water, it would feed into the boiler B and continue to do so as long as there was water in this receiver, regardless of how much water was in the boiler. By the time the receiver tanks were filled again, the water level in the boiler would drop so low before again giving water to the boiler that the automatic city feed-water regulator F would function and let city water in, helping to flood the boiler.

The trouble was overcome by changing the steam connection to the trip T_2. The line D, which supplied the steam to the trap was reconnected to the boiler, through the line E and the middle try-cock M. The connection at the try-cock was made as shown in the detail A.

In this way, when the water in the boiler rose to the normal level at the middle try-cock, it would feed water



Changes made in the steam connection to the feeding trap to make the operation automatic

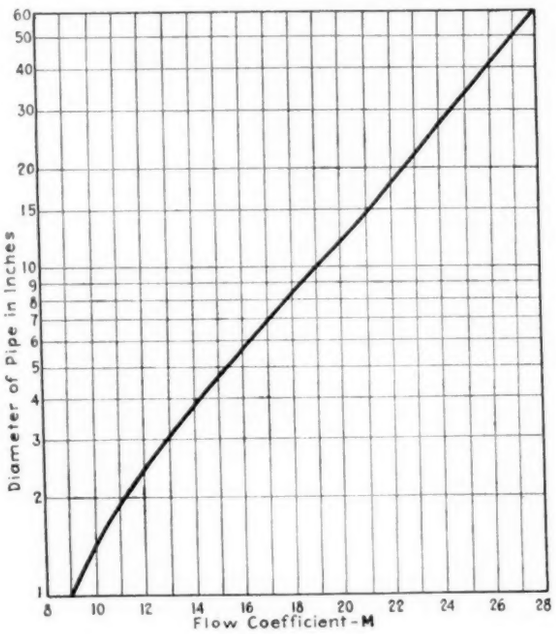
to the trap T_2 and prevent it from functioning. If the water level dropped so as to give steam, the trap would function, giving automatic operation that was satisfactory.

Dayton, Ohio. C. W. STEVENS.

Calculation of Water Flow Simplified

ONE of the simplest formulas for determining the flow of water through pipes is Trautwine's. While many formulas have been published on water flow, I have found this a most convenient one for calculating discharges from pipes. By means of the curve shown in the figure, the various complicated constants usually found in flow formulas are consolidated and read as a single coefficient which occurs outside the radical in the formula given below.

The formula is given in the "National Tube Handbook," but with diameters of pipe expressed in feet, which makes it rather unhandy for small sizes of pipe. The accompanying curve has therefore been plotted with



Value of flow coefficient M for various sizes of pipe

pipe diameters in inches. According to the handbook, this formula has been found to be correct within 5 to 10 per cent and has checked closely in work done by the author.

The formula as given was

$$v = m \sqrt{\frac{hD}{L + 54D}}$$

For use with diameters in inches this reduces to

$$v = \frac{m}{2.45} \sqrt{\frac{hd}{2L + 9d}}$$

which becomes

$$v = M \sqrt{\frac{hd}{2L + 9d}}$$

where

v is mean velocity in feet per second;
D is diameter of pipe in feet;
d is diameter of pipe in inches;
h is total head in feet of water;
L is total length of pipe in feet;
m is coefficient as given in "National Tube Handbook;
M is coefficient obtained from the accompanying curve.

Dayton, Ohio. L. G. JONES.

COMMENTS *from* READERS

Notes on Oil Firing

IN REFERENCE to the article entitled, "Notes on Oil Firing," by R. L. Tullis, in the July 5 issue: Mr. Tullis says "It is good practice to have two suction lines in every oil service tank if uninterrupted service is required."

This statement sounds impractical from an engineering point of view. It just isn't done. Perfect service can be had from one fuel-oil suction line if properly installed. It is not uncommon to see an oil unit—for instance, a 3x2x4-in. steam pump—furnishing oil for a 3,000 sq.ft. boiler with but a 1¼-in. suction, perhaps 50 ft. long, and as many as eight 90-deg. short turns. With suction lines of this kind the plungers begin racing, there is pressure trouble, and the unit is usually condemned.

A suction line should be as short as possible, of pipe not smaller than 2-in., should have only such turns as cannot be avoided, and these should be of the long-radius type. Pipe bends are always preferable. It must be understood, that the fewer connections we have in a suction line the less danger there will be of air leakage. It is a good plan to give the new line a vacuum test before putting it in operation.

Mr. Tullis links the water trouble as a reason for two suctions. The best way that I know of to get water out of an oil storage tank is to pump it out. The end of the suction line as a rule is 12 or 18 in. up from the bottom of the tank.

Oil heaters have drains so the water may be readily removed, and if the storage tank is kept clear of water, none will enter the heater except possibly that moisture which is soluble in the oil and part of which settles when heated. I agree with Mr. Tullis that water in the oil may cause serious trouble. But this, like many other things, can be easily avoided with proper attendance.

If steam is used for atomization, the line should come direct from the boiler and should be well insulated.

The burner Mr. Tullis writes of, must be a rather delicate affair to require strainers on the steam line. If a pressure gage is installed on the discharge line between the oil strainer and the burner and another between the pumping unit and the strainer, a dirty strainer is readily detected. With a strainer on the suction line a vacuum gage can be placed on each side of the strainer.

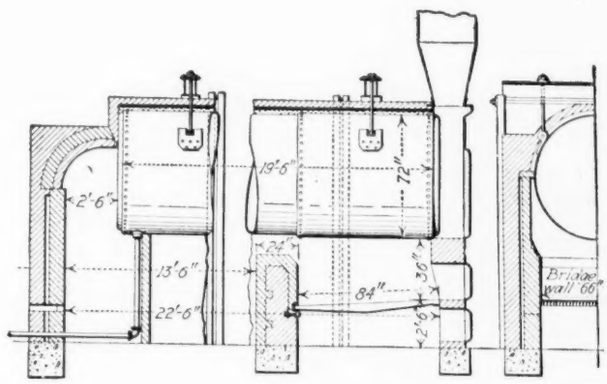
While white smoke or steam emitting from the stack generally indicates an irregularity, it has an exception. This is sometimes due to the hydrogen content of the oil, which, united with eight parts of oxygen, is burned in the furnace and passes over the heating surfaces in the form of a superheated steam and upon striking the air after passing through the stack, is condensed to H_2O. The hydrogen content of fuel oil of course varies, but 12 per cent can be safely taken as an average for ordinary cases.

Monterey, Calif. A. MAIER.

What Is the Best Type of Furnace for Return Tubular Boilers?

COMPLYING with the request of Burton W. Wheeler in the April 26 issue as to what is the best type of furnace for return-tubular boilers, I would like to present a sketch and other details of a setting I have found satisfactory.

The important dimensions are given on the drawing, so these will not be repeated. The combustion space required is 523.6 cu.ft., giving a ratio of combustion volume to water-heating surface of 0.286. The bridge wall should be built free of the side walls with a 1-in. space filled with asbestos. The combustion chamber from the rear of the bridge wall to the inside of the rear wall should be full depth on a line with the ashpit floor or a depth of 5½ ft. below this. The blowoff pipe should be protected by a V-wall built into the floor of the combustion chamber.



General arrangement of setting with dimensions

The furnace and combustion space should be lined throughout with firebrick, and the side wall should be 30 in. thick with a 2-in. air space filled with dry sand, with the rear wall 18 in. thick. Suitable buckstays should be put on the side and rear walls. The boiler should have a 2-in. layer of asbestos over the entire top and a layer of brick on edge over the asbestos. A liberal coating of plastic cement over the entire outside of setting will not only serve as a protection from leaks but improve the looks of the setting.

Owing to the moderate temperature of this furnace and combustion chamber, it will not require any special high-grade firebrick to withstand this heat. The ashpit floor should be finished in cement.

With a furnace constructed to the dimensions given I have had boilers of this capacity up to 180 per cent normal rating. The furnace shown was designed for service where as near complete combustion as possible

was desired, and the operating results were satisfactory.

Give the setting plenty of time under a slow fire before putting it to work—if possible, a week—then take on a small load, gradually increasing it to full load.

St. Paul, Minn. O. F. DUBRUIEL.

* * * *

Why Do the Boilers Shake?

AFTER looking over E. D. Hewlett's sketch of his piping layout in *Power* of July 5, I think his trouble is due solely to the generous size of all his piping. While he does not state the size of the leads from his 3,000-sq.ft. horizontal-tubular boilers (and, by the way, they are evidently very large for their type), I assume from the sizes of pipes given in the sketch, that the same proportions given will apply to the boiler leads.

There is an 8-in. line to the shotgun feed which is about four times the capacity necessary. An 8-in. line leads to the dry-kilns, and while the amount of radiation in the kilns is not given, I assume from the size of the engine, and consequently the capacity of the mill, that in the four kilns there is not more than 8,000 lineal feet of 1-in. pipe. A 3-in. line supplying steam at 120 lb. reduced to 15 lb. would be ample for the kiln job. The 24 x 42-in. engine has a 10-in. supply line, when an 8-in. one would be ample.

If the boilers have 3,000 ft. each of heating surface, 6-in. leads will be ample, but from the proportions of the rest of the piping I assume these leads are much larger, and if so, here is the cause of the trouble. If the boiler leads are of such a size that there is no perceptible drop in pressure between the boilers and the header, at certain loads a violent pulsation is set up between the boilers and the engine, or rather from the engine to the boilers. This, I think, depends on the length of the lines and the timing of the pulsations due to the speed at which the engine is running.

Some years ago I had charge of six 3,000-sq.ft. vertical water-tube boilers, all connected to a 16-in. header. Three of these boilers, installed in the year 1900, had 8-in. leads, the other three, built by the same makers in 1907, had 6-in. leads. No pulsation was ever noticed on the latter boilers, but those with the 8-in. leads shook quite violently at times.

I decided to install non-return valves on all boilers, and these valves worked perfectly as far as the non-return and cut-in-and-out features were concerned, but while the 6-in. valves did not flutter, the 8-in. fluttered violently at certain loads. After a time the 8-in. valves gave trouble by breaking the disks off the stems, and for some time I was at a loss as to the cause of the trouble.

Now at another plant owned by the firm we had three boilers of the same size and make, installed in 1906, which had 7-in. leads. The question arose in my mind, why the change in the size of the boiler leads between 1900 and 1907? I assumed the builders had found a good reason for reducing the lead sizes. I induced the valve company to build me an 8-in. valve with a 6-in. opening, so I could install it without any change in the piping. This valve gave satisfaction, and we changed the other 8-in. valves in the same manner with success.

Recently I came across another trouble of the same nature. Two 1,750-sq.ft. horizontal-tubular boilers supplying steam to a 20 x 21-in. 200-r.p.m. Buckeye engine as well as to dry-kilns and process work, fed the steam through 8-in. leads to a 10-in. header. These boilers shook violently under a heavy load, and a reducing valve had been installed in the 7-in. engine line. When the reducing valve was in service, the boilers were quiet, but when it was cut out, they shook badly, except when the engine load was very light. I replaced the 8-in. leads with 5-in. ones and the trouble immediately stopped.

I hope Mr. Hewlett will eventually tell us what he found to be the cause of the trouble and what he did to correct it.

Cleveland, Ohio. C. A. GREEN.

* * * *

IN ANSWER to the query on page 25 of the July 5 issue "Why do boilers shake?" I would say that this trouble has been met with before and is associated with improper combustion.

This shaking is most frequent when the plant is operating at full capacity and seldom occurs when the load is light. The remedy is the supplying of more air under the grate, in this case in the Dutch oven, so as to complete combustion within the furnace. A small propeller-type blower or a steam-air pet is used in some instances.

The lack of air causes a series of small explosions when unburned gases comes into contact with air, which find their way through unsuspected leaks beyond the fire.

New York City. JOHN GARDNER.

* * * *

What Causes the Fusible Plug to Corrode?

IN REPLY to the query "What Causes the Fusible Plug to Corrode?" asked by C. W. Howard in the June 14 issue, the following comments may be of interest:

It has been believed by many investigators that the corrosion of metallic articles by liquids is intimately connected with the flow of electric currents through the liquid between different parts of the metallic surface. In power plants I have observed upon many occasions that the junction of dissimilar metals did constitute the seat of severe corrosion and that the heterogeneous materials were more liable to attack than homogeneous materials. It is also known that perfectly inert non-conducting bodies, such as scale or sand, resting on metal surfaces could initiate corrosion, and that the so-called differential aëration currents set up by variations of oxygen concentration explain many cases of pitting. For example, if a crack or pore in a piece of metal, or a crevice between two pieces of metal becomes filled with liquid, the interior will become anodic to the main part of the surface, and corrosion will take place, enlarging and deepening the original cavity. The initiation of honeycombing may also be due to invisible pores originally present in the soft metal of the plug.

It may be of interest at this stage to mention that the Bureau of Standards some few years ago investigated the failure and deterioration of fusible tin boiler plugs, about 1,000 examples being examined, of which 100 had been in service. In some cases, in which such plugs failed to melt and give warning of dangerous boiler conditions, investigation showed that the tin filling had become oxidized to tin oxide, which has a melting point above 2,500 deg. F., whereas the pure metal melts at 450 deg. F. In a number of plugs it was noticed that oxidation of the tin had taken place along the grain

boundaries, resulting in the formation of a network of oxide throughout the tin, and these plugs were found to contain from 0.5 to 4 per cent of zinc, which was held to be the cause of failure.

It is fairly well known that zinc is not soluble in the solid state in tin, and when tin containing small amounts of zinc is heated in a boiler to about 350 deg. F. the zinc coalesces as a network enveloping the tin crystals or grains. The boiler water, particularly if it contains alkali, attacks the zinc, eating its way into the alloy along the zinc network, and finally forming the oxide network. Lead and zinc were found to be the principal impurities in tin plug fillings, and since all the plugs that failed contained these or other impurities, the conclusion was that the danger of failure of fusible tin boiler plugs would no longer exist if impurities were eliminated by strict specifications and inspection, which would allow only admittedly superior qualities of tin to be used.

Probably the best fusible boiler plugs are those sold by certain of the leading insurance companies. These have been designed from long experience with the working of steam boilers of all classes and have been gradually modified and improved as experience has shown to be necessary. Many boiler attendants appear to be under the impression that once a plug has been screwed in the plate, its existence and function may be forgotten. To this impression is largely due the somewhat customary belief that fusible plugs are not reliable. A fusible plug is likely to become scaled on the water side and coated with soot and dirt on the fire side. It is also likely, as experienced by Mr. Howard, to corrode, while the alloy may be affected in course of time by long exposure to the action of the furnace gases.

Frequent cleaning is really a matter of paramount importance, as also is the changing of the fusible alloy occasionally. The alloy undoubtedly becomes oxidized or corroded in course of time and may not melt at the temperature originally decided upon. Fusible boiler plugs should be replaced with new ones at least once a year, as the melting point tends to rise under continued heat.

The corrosion of the "brass bodies" often takes place, and severe wastage will sometimes occur, particularly about the threaded part where the plug is screwed into the shell of the boiler. Leakage has been known from that cause so serious as to necessitate the shutting down of the boiler. The possibility of corrosion taking place must not be overlooked, and the plug should occasionally be taken out and examined.

Although the ordinary procedure in refilling fusible boiler plugs is usually well understood, the following details are important.

1. Properly cleaning and tinning the brass plug interior.
2. Preheating of the brass outer casing before tinning and filling.
3. Correct temperature of the fusible metal.
4. The handling and pouring of the molten metal in the brass body or outer casing.
5. Reliability of source of supply of fusible metal.

One cause of the failure and deterioration of fusible boiler plugs is the loosening of the fusible metal in the brass plug. This can be prevented by a thorough cleaning of the plug before the molten metal is poured and by using the proper tinning methods. The tinning alloy generally used is a 50-50 solder. Too much care cannot be taken in fluxing the surfaces to be tinned, in order to secure perfect adhesion of the fusible metal. If any untinned places can be detected on the surface after the tinning process, repeat the operation. Immediate filling without intermediate cooling is preferable for good fusion between the fusible metal and the brass plug.

It is important that the fusible alloy or metal be kept within certain definite temperature limits, as experience has shown that a perfectly good metal can be made practically worthless for boiler plugs by allowing it to rise to too high a temperature and also by pouring either too hot or too cold.

The best method to employ to meet the unavoidably corrosive action of "tin pest," "bronze disease," etc., is to use only metals that are practically pure, in the fabrication of fusible boiler plugs.

Manchester, England. E. ANDREWS.

* * * *

Losses in Air Ducts and Bends

THE editorial in the July 12 issue commenting on the findings of H. Loring Wirt on the "Losses in Air Ducts and Bends," published in the *General Electric Review* for June, is worthy of discussion. The statement is made that "losses may be reduced 10 per cent by replacing a rounded elbow of usual design by a square turn. This is contrary to accepted ideas, although it has been known for some time in connection with intake manifolds on automobile engines." It seems to me that this conclusion is rather far-fetched.

The reason for the use of the unconventional square-turn manifold on automobiles is to give uniform distribution of the mixture to each of the cylinders, thus insuring uniform power or smoothness of operation, of the engine. Further, it is admitted by the manufacturers that it is not as efficient as the conventional rounded type of manifold, meaning by this that the losses are greater. The mixture of gasoline vapor and air, usually a misty composition, due to the low end points of the gasoline, can hardly correspond to the flow of air in a pipe and duct. By the very nature of the square turn, the agitation of the flow maintains a certain amount of the raw gas in the air stream, thus insuring a more or less proper mixture for each cylinder. It is this agitation by impingement that causes loss of head.

It seems rather doubtful if the results of Mr. Wirt's findings are of much value for general acceptance in design of ducts. A study of the layout of Mr. Wirt's equipment shows that it does not confirm to the conditions under which an elbow would be used in actual practice. In the layout a rounded approach orifice preceded the model elbow, or elbow and tail pipe of four diameters, with discharge into the atmosphere. Such a discharge is known as a free discharge.

In fluid measurement it has been established by experiments that a given size metering element mounted on the end of a pipe with free discharge does not have the same coefficient when mounted in a pipe. This is probably due to the difference in the flow corresponding to the mountings, and is indicated by the difference in the coefficient. Probably the same conditions result with an elbow. This would seem reasonable in view of the unusual results as found by Mr. Wirt. Therefore, it seems, until further tests with elbows actually in the piping, substantiate these unusual findings, the results should be used with caution for pipe or duct installations other than the conditions under which the tests were run by Mr. Wirt.

State College, Pa. A. J. NICHOLAS.

New and Improved EQUIPMENT

Wright-Austin "Kleervu" Gage-Glass Protector

In the accompanying illustrations is shown the new "Kleervu" gage-glass protector recently developed by the Wright-Austin Co., Detroit, Mich. It consists of a U-shaped wire-inserted glass $\frac{5}{8}$ in. thick that completely incloses the gage glass. A heavy wire screen at the back prevents flying particles of glass from striking the column and rebounding outward. The sides of the screen are bent at right angles to fit snugly against the glass to prevent particles of glass from being blown outward, while at the same time allowing the steam to escape through the openings of the mesh. On the screen, brackets are provided top and bottom that fit against the packing nuts of the gage glass and are held in place by springs.

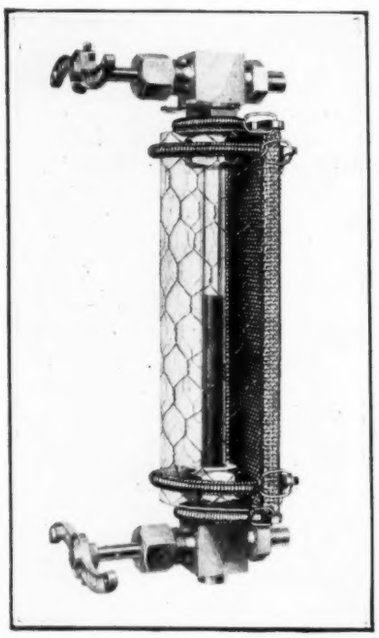


Fig. 1—Gage glass protector in place

Other springs clamp the U-shaped glass into place against the screen. These springs are hooked into place by rings that fit over shoulders on the brackets.

Elimination of supporting rods give a clear view through the glass protector from every direction except the rear. The wire in the glass does not obstruct the view of the water level. An advantage claimed for the protector is the protection afforded against breakage of the gage glass by shielding it from cold drafts.

In addition to its use on steam boilers, the protector is available for practically all kinds of liquid level gages, such as

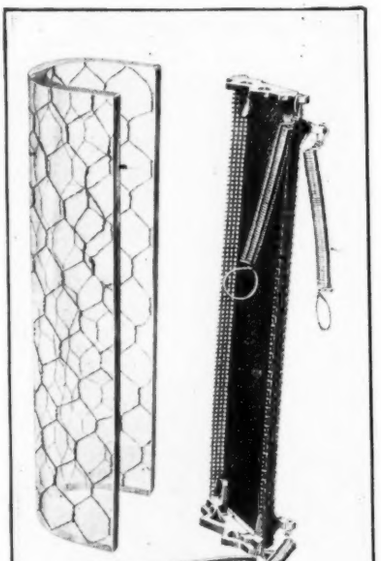


Fig. 2—Protector dismounted

those on ammonia stills, chemical containers, steam separators, steam accumulators, air receivers, etc.

National Sleeve-Valve Air Compressor

A departure from the conventional line of air compressors is the sleeve valve compressor recently brought out by the National Brake & Electric Co., Milwaukee, Wis.

Referring to the illustration, Fig. 2,

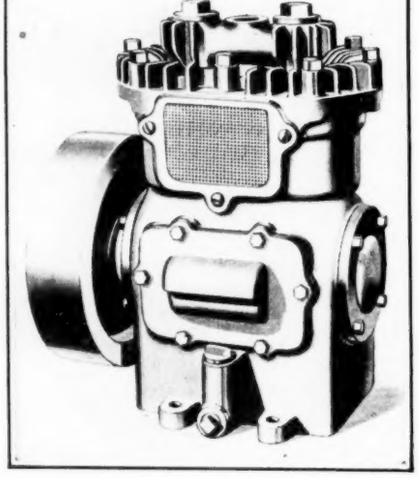


Fig. 1—Sleeve-valve two-cylinder compressor

which shows an air-cooled single-cylinder unit, the sleeve intake valve *A* is of large diameter and small lift (less than $\frac{1}{4}$ in.). The valve is opened and closed through the friction of the piston rings against the inner wall of the sleeve. In the down or suction stroke of the piston *B* the friction of the rings causes the sleeve *A* to move downward against the cushioned stop *C*. This permits air to enter the cylinder through the circular opening between the end of the sleeve and the valve seat *D*. Immediately the

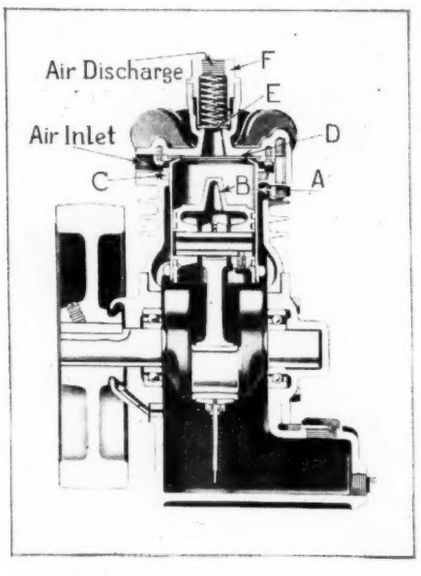


Fig. 2—Cross section of single-cylinder unit

piston starts upward, the friction of the rings causes the sleeve to seat at once and the air is then forced through the discharge valve *E*. This valve is simply a thin steel disk, spring-weighted and having a small lift, the lift being limited by an extension sleeve on the valve cap *F*. The seat *D* of the inlet valve consists of two thin phosphor-bronze disks or rings mounted on the cylinder head and held in place by a retaining ring. These rings, due to their flexibility and method of mounting, provide a cushion-like seat for the sleeve valve *A*.

The crankshaft, which is die-forged and heat-treated, is carried in ball bearings. The crankpin bearing is of the bronze-backed split type lined with babbitt. The compressor can be operated at high speed permitting direct connection to 1,160-r.p.m. motors, thereby eliminating the use of belts or reduction gears.

The compressors are being built in various sizes for pressures up to 150 lb. and are available in either the air or combined air and hopper water-cooled types.

RECENT PUBLICATIONS

DIRECTORY OF COMMERCIAL TESTING AND COLLEGE RESEARCH LABORATORIES. Department of Commerce, Bureau of Standards, George K. Burgess, Director. Miscellaneous Publication, No. 90. Price, 15 cents.

This directory lists geographically the commercial and college testing and research laboratories in the United States. A system of key notations indicate the kind of work each laboratory is capable of handling. To those desiring laboratory service this directory should be of considerable benefit.

TWENTY-FIRST ANNUAL REPORT OF THE BENGAL (INDIA) SMOKE NUISANCES COMMISSION, 1926. Calcutta, Bengal Secretariat Book Depot.

Those who are interested in studying smoke-abatement work will be interested in the twenty-first annual report of the Bengal Smoke Nuisances Commission, for the year 1926, obtainable from the office of the commission in Calcutta. It outlines the situation in Calcutta and discusses briefly the methods, among them the use of air preheaters, for burning cheap fuels in industrial power plants, the use of electric power in mills and the use of gas for domestic heating needs. The commission, it appears, began work in 1906, and has effected a reduction of smoke in that busy city from 13.1 to 0.98 min. per hour of equivalent No. 6 smoke.

This 8-page pamphlet is not a source of any particular technical information, but it does indicate how widespread is the smoke problem and the determination of people to have done with it.

YEAR BOOK ON COMMERCIAL ARBITRATION IN THE UNITED STATES, 1927. Prepared by the American Arbitration Association, 342 Madison Avenue, New York City. Published, 1927, by Oxford University Press, American Branch, 35 West 32nd Street, New York City. Cloth; 6 x 9¼ in.; 1,152 pages. Price, $7.75, postpaid.

This is the first of a series of standard publications on arbitration being prepared under the direction of the Research and Publications Bureau of the American Arbitration Association. The Association is a voluntary educational organization, supported by dues and contributions. It serves business through the promotion of arbitration to eliminate the notorious delay, expense and bad after effects of litigation. It acts as an educational body, as an agency to assist other bodies in setting up effective machinery for arbitration and as a practical tribunal where members and friends of arbitration may arbitrate their disputes speedily, justly and at negligible cost. The list of officers and directors of the Association includes such names as Herbert Hoover, Charles E. Hughes, L. R. Eastman (president), Charles M. Schwab and Owen D. Young.

This Year Book describes in great detail the existing machinery for the arbitration of commercial disputes. The extent and availability of these facilities will probably come as a surprise to many business men and industrialists. In the first 42 pages the Association is described, with detailed instructions for conducting arbitrations under its auspices.

The body of the book is a complete outline of the existing arbitration arrangements in practically every important industry. Each industry is treated separately, with details of the arbitration procedures now in use by its various societies and trade associations.

This treatment by industries is followed by a description of the arbitration rules of the United States Chamber of Commerce, the International Chamber of Commerce and local Chambers all over the United States.

Four "annexes" give concise summaries as follows: I-A summary (by states) of the statutes governing commercial arbitration; II-The United States Arbitration Act; III-How to arbitrate under the New York law; IV-Arbitration practices in thirty-two countries.

The great mass of material it contains is no hindrance to the convenient use of this Year Book. With the aid of name and subject indexes the busy executive can quickly locate those sections relating to arbitration as it exists today in his particular industry or field of work. He will find specific data, names and addresses of organizations, forms and rules of procedure with which he can easily chart a practical course of action. If this book leads to a more general understanding and acceptance of the economics of commercial arbitration, it will help eliminate one of the most glaring wastes in modern industry.

ELECTRIC ELEVATORS. By F. A. Annett. Published by McGraw-Hill Book Co., 370 Seventh Avenue, New York City, 1927. Cloth; 6x9 in.; 447 pages; 351 illustrations; 4 tables; 3 folded inserts. Price, $5.

Electric freight and passenger elevators have come to be one of our important transportation systems. In large cities, as many passengers are carried on vertical systems of transportation as there are handled by street railway traction systems. Most of the other transportation systems have an extensive literature, but the electric elevator has not been so favored, very little having been published in book form on this subject. This new book, coming at a time when elevators have been passing through an active period of development, treats various types of modern electric elevators.

What the author has to say on early-type elevators is in the introductory paragraph of the first chapter, which covers the period from Archimedes to the introduction of the electric elevator. In the first chapter a general review is given of the different types of electric elevators now in use, including micro-leveling, automatic-landing and signal-control types of machines. Chapter two deals with the different methods of applying alternating current to elevator equipment and discusses the various types of motors and controls used.

Three chapters are devoted to the subject of elevator cables, giving the various arrangements used, the kinds of cables, their reserve strength, methods of replacing cables, etc. Governors and car safeties, thrust bearings and lubrication have a chapter devoted to each of them. Direct-current brakes and alternating-current brakes are each the subject of a chapter. Troubles in elevator equipment have been treated extensively in three chapters; locating faults in mechanical equipment, direct-current motors and controllers, alternating-current motors and controllers—these subjects have 80 pages allotted to them.

An extensive part of the book is the 12 chapters in which control equipment is discussed. One of these covers the fundamental principles of control; another, types of reversing switch; and 10, standard types of control equipment. The operation of 25 different controllers, for which diagrams are given, has been explained in detail. These range from the simple single-speed semi-magnet type to those used on modern high-speed passenger elevators. Both direct- and alternating-current types are included. The wiring diagrams for these controllers have been made of a working size. Where one page would not provide sufficient space to do this, the diagrams are printed separately and inserted.

The treatment of the different subjects has been from the point of view of the practical elevator man, and the equipment dealt with covers a wide range of subjects. For those who are associated with elevator problems, the book should find a wide field of usefulness and help fill a long-felt need for such a work.

INTERNATIONAL SYMBOLS, Part 2, has recently been issued in the form of a 40-page book, by the International Electrotechnical Commission and is known as Publication No. 35. These graphic symbols are recommended standards, to denote various machines and devices, for use in laying out electrical transmission and distribution systems and in making diagrams of connections in electrical engineering. The text is published in both French and English. Copies of this publication can be obtained at $1 each, by writing to the International Electrotechnical Commission, 28 Victoria St., Westminster, S.W.1, London, England.

NEWS *of the* FIELD

Breaking Drive Belt Causes Flywheel Explosion

A racing flywheel at the saw mill of the Bagdad Land & Lumber Co., Bagdad, Fla., exploded with great violence Aug. 8, causing much damage to equipment but no serious injuries.

The flywheel exploded by centrifugal force with such force, according to information released by W. H. Boehm, vice-president of the Fidelty and Casualty Co., New York City, that a heavy piece of the wheel was hurled a distance of more than a thousand feet, where it penetrated five feet of lumber and plunged into the river. Several fragments were shot through mill timbers of fourteen inches thickness.

The engineer had left the engine to get a drink of water. He was within twenty feet of it when he saw the main driving belt break. He heard a crash as if the belt had struck something, and saw the engine speed up. While he was trying to get to the throttle valve, another man shut the valve on the main steam line. But this was too late. When the crash came both men were showered by falling debris. Fortunately neither was seriously hurt.

Besides the destruction of the wheel, there was also destroyed the main driving belt, a 36 x 30-in. receiving pulley, a 30 x 30-in. binder pulley, an oiler pulley, two hanger boxes, a pillow block and about 21 feet of tubing. The cylinder head of the engine was broken, and the connecting rod and piston rods were bent.

The accident was caused by the breakage of the main driving belt where the two ends were spliced together. The belt struck and dislodged a ceiling beam which fell upon and broke one of the governor rods. This allowed the engine to take steam at full stroke, thus causing it to race.

The amount of the loss caused by this accident has not yet been determined, but it is fully covered under a policy of fly-wheel insurance which has been carried by the Bagdad Land and Lumber Company for a considerable number of years.

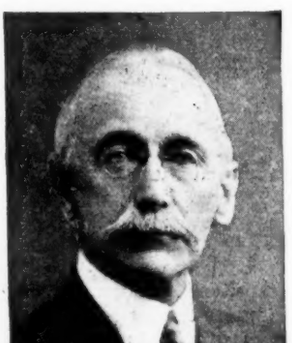
Urges Power from Coal In Alberta

Development of electrical power from coal rather than from water power is advocated for Alberta, Canada, by Hon. Charles Stewart, Minister of the Interior.

Discussing the Alberta Spray Lakes power site, Mr. Stewart thought that Albertans would be much farther ahead to develop electrical power from coal, since there are such quantities in the Province. Electrical power, he said, could be manufactured just as cheaply from coal as from water power and would provide more employment. Also it would not spoil any of the natural beauties of the approach to the Banff National Park.

Dr. Alexander C. Humphreys, Stevens President, Dies

Dr. Alexander Crombie Humphreys, who retired last July as president of Stevens Institute of Technology after



Dr. Alexander C. Humphreys

twenty-five years' service, died on Aug. 14 at his home in Morristown, N. J.

From 1902 to 1927 Dr. Humphreys was president of Stevens Institute of Technology and remained as chairman at the time of his death. He held degrees from the University of Pennsylvania, New York University, Columbia University, Brown University, Rutgers University and Rensselaer Polytechnic Institute.

Dr. Humphreys was an engineer of the first rank, having been chief executive of fifty gas and electric companies. He was born March 30, 1851, in Edinburgh, Scotland.

He was a former president of the American Institute of Consulting Engineers, the American Society of Mechanical Engineers, the American Gas Institute, the Canadian Society of New York, the American Gas Light Association, the Engineers' Club and the St. Andrews Society and was a member of the United Engineering Society, the National Society for the Promotion of Industrial Education, the American Association for the Advancement of Science, the British Association for the Advancement of Science, the Society for the Promotion of Engineering Education, the American Society of Mining and Metallurgical Engineers, the American Society of Civil Engineers, the Institution of Civil Engineers of Great Britain.

New Concern Develops Dry Quenching Coke System

Acquisition from Sulzer Brothers, Winterthur, Switzerland, by the International Combustion Engineering Corp. of the Sulzer System for dry quenching coke, which will be developed in this country by a new subsidiary, Dry Quenching Equipment Corp. has been announced by George E. Learnard, president of International Combustion Engineering.

The Sulzer System is widely used in Europe for cooling coke without the use of water. Steam is produced for power and plant purposes during the cooling process, thus diverting to useful work the sensible heat of the coke, which is at present lost by wet quenching.

The first unit in America was installed by Sulzer Brothers for the Rochester Gas & Electric Corp., "where the equipment is exceeding the manufacturer's guarantee in daily operation."

The directors of the new corporation are: George E. Learnard, chairman; H. D. Savage, president; G. G. G. Hunter, vice-president; George H. Hansel, treasurer; Hans Sulzer, of Winterthur, Switzerland; F. Oederlin, of Winterthur, Switzerland; E. N. Goodwin, New York.

Walter Sennhauser, at present connected with Sulzer Brothers of Winterthur, will come to this country as chief engineer.

Lexington Water Power Gets Saluda Project Liscense

A 50-year license for a power project on the Saluda River in South Carolina, which will have an ultimate development of 260,000 hp., installed capacity, was granted to the Lexington Water Power Co. of Columbia, S. C., by the Federal Power Commission on Aug. 5.

The project, it was stated orally at the Commissioner's office, will be at Dreher's Shoals, and will extend into the counties of Lexington, Richland and Newbury. It will consist of a dam, with fill, of about 8,000 ft. crest line, and a cut-off embankment 1,000 ft. long, the crest elevations of each to be 372 ft.; a reservoir with an area of 76 square miles; six penstocks, and a power house with six 32,500-kw. units under a 183-ft. head.

Mohawk-Hudson Power Plans Consolidation of Five

In a proposed consolidation of power companies in the Albany district of New York under the Mohawk-Hudson Power Corp., before 1928, approximately $100,000,000 will be involved, it has been made known.

Companies involved are the Municipal Gas Co., Albany, Troy Gas Co., Adirondack Power & Light Corp., Adirondack Electric Power Corp., and the Fulton County Gas & Electric Co., all subsidiary to the Mohawk-Hudson Power Corp., and the Eastern New York Utilities Corp. with its gas and electric business in Rensselaer and Columbia counties.

Three major steps necessary to the consolidation are not expected to appreciably delay the accomplishment. They involve permission of stockholders of the companies, the public service commission's consent, and the issue of new bonds to replace those called in under the consolidation.

The aggregate capital and surplus of the companies involved is approximately $100,000,000, according to Charles S. Ruffner, president of the Mohawk-Hudson Power Corp.

Lower Rate Promised

The alleged intent of the consolidation is to substitute one operating utility company for the several now operating in adjoining territories. This will, it was said, make possible a lower rate and better service because of the decrease in operating expenses.

The merger will result in service by the one company for all communities lying between Hudson and Lake Champlain, and from Rensselaer west including Albany, Troy, Cohoes, Schenectady, Johnstown and Gloversville and all communities west to Oneida and Canastota.

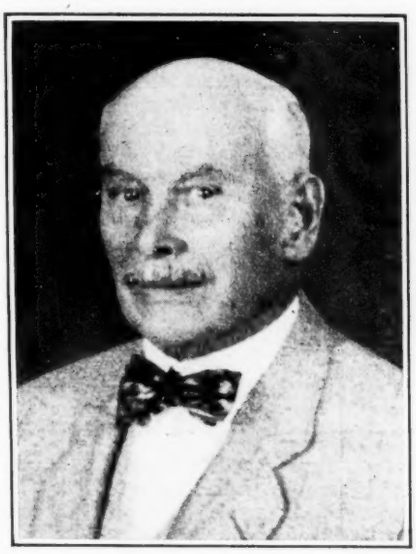
Elbert H. Gary, Head of United States Steel, Dies

Judge Elbert H. Gary, chairman of the board of directors of the United States Steel Corp., died at his home in New York City, after a long period of ill health, Aug. 15.

Elbert H. Gary was born on a farm near Wheaton, Ill., in 1846. He was educated in the public schools of Wheaton, and when the Civil War broke out was a student in the Illinois Institute. After the close of the war, Mr. Gary entered the Union College of Law at Chicago and was graduated at the head of his class in 1868. After serving a few years as clerk in the Superior Court he went into business for himself and was immediately successful. His colleagues at the bar induced him to run for the office of judge in Du Page County, and he served two terms in that capacity.

In 1892, when Judge Gary first became interested in steel and his career became identified in the public mind with the creation of the United States Steel Corporation and with its subsequent growth, he had been a practicing lawyer.

The Illinois Steel Co., established during the Civil War, had been in serious financial difficulties in 1893. Judge Gary had been called into consultation and had been made general counsel, the beginning of a close association with the board of directors. Only a few months after he had completed his work on the American Steel and Wire Co. organization he directed the amalgamation of the Illinois Steel Co. and the Minnesota Iron



Judge Elbert H. Gary

Co. under the name of the Federal Steel Co., a $200,000,000 corporation. When the work had been completed Judge Gary was asked to become president of the Federal. He took up his duties as president in October, 1898.

Following prolonged negotiations in which J. Pierpont Morgan and Judge Gary played the leading rôle, the United States Steel Corporation was formed from the Federal Steel Co., the Carnegie Steel Co., the National Tube Co., the American Steel and Wire Co., the American Bridge Co., the Lake Superior Consolidated Ore Mines, and the tin plate, steel hoop, and sheet steel companies. The new corporation was capitalized at $1,100,000,000 and had a bonded indebtedness of $300,000,000.

The billion dollar corporation began business on April 1, 1901, with Charles M. Schwab, a Carnegie man, as president, and Judge Gary as executive head. The company at that time controlled almost exactly half of the rolled steel products of the country. Judge Gary continued as executive head until 1903, when Schwab retired as president; W. E. Corey became president, and Gary chairman of the board of directors.

Judge Gary's leadership in the steel industry made him one of the most valuable of private citizens to the Government during the war.

While Judge Gary belonged to more than forty clubs and organizations, it was the American Iron and Steel Institute which won the greatest amount of his interest.

Argentine Asks Bids on Three Power House Installations

The Argentine Ministry of Public Works has called for bids on the provision of equipment and construction of electric power and water pumping plants for the towns of San Nicolas de los Arroyos, Rafaela, Province of Santa Fe, and Rosario de la Frontera, Province of Salta. This includes the complete installation of the plants together with the underground water main, and the turning of them over in complete working condition.

The lighting plants for the three cities are each to contain three diesel motor driven direct connected generators of 220v., 50 cycle, 125 kva. capacity, together with auxiliary pumps, fuel storage tanks, and electrical switching equipment.

The water pumping station will contain nine electric driven pumps and five diesel motor driven pumps. Four electric driven 300 g.p.m., 160 to 200 ft. head pumps are to be installed at Rafaela, and five 450 g.p.m., 50 ft. head electric driven pumps at San Nicolas. The five diesel driven pumps are to have a capacity of 265 g.p.m. The three installed at Esperanza in the Province of Santa Fe are to develop a head of 130 to 145 ft., the two installed at Rosario de la Frontera are to develop 80 to 100 ft. head. All pumps are to be of the deep well type.

Great Lakes N.E.L.A. Men Convene in September

Word has been received that preparations are afoot for the seventh annual convention of the Great Lakes Division of the National Electric Light Association which will take place at French Lick Springs Hotel, French Lick, Ind., Sept. 22-24.

Company members of the Great Lakes Division will be represented by delegates and participating speakers from Wisconsin, Illinois, Michigan and Indiana.

A number of men among the most prominent leaders in the electric light and power fields have accepted invitations to address the sessions. A partial list includes:

Howard T. Sands, president of the National Electric Light Association, New York City; J. F. Owens, chairman of the Public Relations Section, N.E.L.A., Oklahoma City, Okla.; Dr. Charles A. Eaton, General Electric Co., Cleveland; Paul S. Clapp, executive manager, National Electric Light Association; B. J. Mullaney, vice-president, Peoples Gas Light & Coke Co., Chicago; E. W. Lehmann, professor of farm mechanics, University of Illinois, Urbana, Ill.; Charles M. Ripley, General Electric Co., Schenectady, N. Y.; Mrs. Edward Franklin White, and Earl Whitehorn, commercial editor of *Electrical World*.

The Great Lakes Division's Women's Committee will have a separate session on Thursday afternoon, Sept. 22.

Stoker Production at Low Point in July

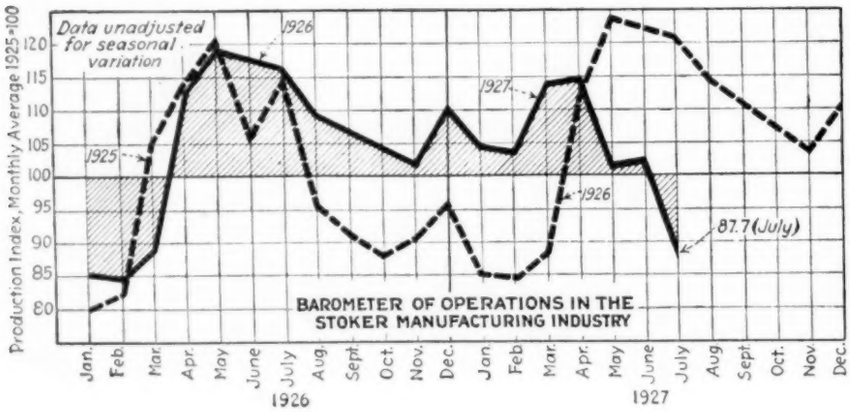
Contrary to the trend exhibited during the past two years, the stoker manufacturing industry appears to have materially decreased its operation during July under those reported for June. The actual July production of stokers was about 15 per cent under that of June. However, when corrections are made for the number of working days it is found that the July rate of stoker production was only about 11 per cent under June, but was apparently about 25 per cent under July of last year. The July operations were the lowest since February of last year.

Such is the status of productive activity in the stoker manufacturing plants of the country, as indicated by the consumption of electrical energy as reported by a number of these plants to *Power*.

Up through June it appeared that the operations of the stoker manufacturing industry were becoming more stabilized, and would not be subjected this year to the great changes in monthly productive activities which were witnessed during 1925 and 1926. The July figures, however, would appear to disprove this theory. The July operations were about 24 per cent under those of April, the high month of activity during the present year, and 14 per cent under the monthly average stoker production during 1925.

Upward Turn Foreseen

There is every reason to believe that July marks the low point of production and that August will witness an upward turn in the production of stoker manufacturing plants. The value of contracts let for the construction of commercial and industrial structures during the past seven month has slightly exceeded similar contracts let during the same period of last year—$918,000,000 for 1927 and $916,000,000 for 1926. The amount which the electric light and power companies of the nation will spend for new steam plant equipment this year as budgeted at the opening of the year, is $252,000,000, practically the same as June, 1926. Based upon these construction facts the opinion is expressed that the comparatively low stoker production during July will give way to a materially higher production with the coming months.



Obituary

Horace W. Rand, of the Ashton Valve Co., died Aug. 5.

Frederick L. Converse, who has been associated with W. B. Coleman & Co., metallugists, chemists, engineers, Philadelphia, for a number of years, passed away Aug. 9, after a brief illness. Mr. Converse was a graduate of Purdue University and in his early days worked for a number of the large generating stations in New York, after which he went to the Midvale Steel Co. plant as steam engineer. He later took a very active part in the construction and the operation of the Tacony Ordnance Corp. breaking ground. Mr. Converse was also with the DuPont Co. in consulting work, and for the last five years associated with the Coleman company as consultant on engineering problems and power plant operation.

Personal Mention

L. L. Fisk, formerly chief engineer of the Pittsburgh Crucible Steel Co., Midland, Pa., is now chief engineer for the Mesta Machine Co., Pittsburgh.

E. B. Meyer, chief engineer for the Public Service Production Co., Newark, N. J., has been appointed chairman of the publication committee of the American Institute of Electrical Engineers.

William E. Brown, manager of the central station department of the New York district of the General Electric Co., has been appointed New York district sales manager. Mr. Brown's headquarters will be at 120 Broadway, New York City.

W. R. Bean, formerly research engineer for the Eastern Malleable Iron Co., Naugatuck, Conn., has entered the employ of the Grindle Fuel Equipment Co., Harvey, Ill., as vice-president and consulting engineer handling engineering problems and sales in connection with the application of pulverized coal to steam boilers, furnaces or other units.

Francis Hodgkinson, consulting mechanical engineer at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Co., sailed Aug. 6 for Europe on a business trip.

A. L. Grossman, mechanical engineer, is now located at the main offices of the Celite Products Co., 11 Broadway, New York City.

C. E. Skinner Sc.D., assistant director of engineering, and W. Bradshaw, of the supply sales department, Westinghouse Electric & Manufacturing Co., will sail for Europe Aug. 17, as delegates to the International Electrotechnical Commission convention at Bellagio, on Lake Como, Italy, Sept. 4 to 24.

R. H. Andrews, formerly a member of the *Power* editorial staff and for the last four years Paris correspondent, has recently accepted a position in charge of the patent department of the Société Anonyme des Foyers Automatiques, the French company of the International Combustion Engineering Corp. This company has its manufacturing plant at Roubért, France.

E. E. Harper, consulting engineer, has moved to 4010 Penn Ave., Kansas City, Mo., where he has opened an office and a shop for the manufacture of dry feed equipment and other devices constructed under his own patents for feeding chemicals in water purification and softening plants. This business will be handled by the Omega Machine Co., of which Mr. Harper is president.

H. A. Adams, Jr., has just returned to New York after being in India seven years as manager for Walworth International Co. of New York. Mr. Adams has been associated with the export of engineering material for a number of years, having been with the Allied Machinery Co., of America prior to going to India. He plans on having headquarters at Room 605, 44 Whitehall St., New York City, for a few months before announcing his new connection.

John Murphy of Ottawa, who, on July 11, was elected president of the Canadian National Committee of the International Electrotechnical Commission, sailed from New York Aug. 16 on the United States Lines Steamship *George Washington* with the American delegates to the Plenary meetings of the I.E.C. which are to be held in September at Bellagio on Lake Como and some days later at Rome in connection with the commemoration of the 100th anniversary of the death of Volta.

Dr. R. Plank, professor of the Technical University of Karlsruhe, Germany, and director of the German Institute of Refrigeration, and Dr. A. Kessner, professor of the Technischen Hochschule, Karlsruhe, landed in New York about a week ago for an extended tour of the United States for the purpose of visiting refrigerating plants and studying American industrial conditions in general. They were entertained at the Engineers Club, New York, Aug. 12.

Business Notes

THE MARION MACHINE FOUNDRY & SUPPLY CO., will celebrate the twenty-fifth anniversary of its founding Sept. 10.

THE L. J. WING MANUFACTURING CO., New York City, recently appointed A. D. Foster, Missouri National Bank Bldg., St. Louis, to handle their line of unit heaters, forced draft blowers, fans, and exhausters in the St. Louis territory.

THE EARLE GEAR & MACHINE CO., with main office and plant at 4707 Stenton Ave., Philadelphia, announces the opening of a New York district office at 95 Liberty St., New York City. C. N. Walsh and George E. Barrett are in charge.

THE PHILADELPHIA GEAR WORKS, makers of gears and speed reducing units, will occupy their new building at Erie Avenue and G Street, Philadelphia, Sept. 1. For the past several years, this concern has been located at Richmond and Tioga Sts., and for many years prior to that, were situated at 1120 Vine St., Philadelphia.

ALLEN-BRADLEY CO., 286 Greenfield Ave., Milwaukee, manufacturers of electric control apparatus, recently appointed W. O. Taylor, & Co., Ltd., 415 Canada Cement Bldg., Montreal, Quebec, Canada, as representatives to cover the Montreal territory including the major portion of Quebec, the eastern part of Ontario and as far west as Kingston.

Trade Catalogs

DIESEL ENGINES—Catalog F of the Bethlehem Steel Co., Bethlehem, Pa., explains the construction and operation of the two-stroke-cycle airless-injection Diesel engine for stationary service.

OIL TEMPERING BATHS—The General Electric Co. has issued bulletin GEA-801, superseding No. 69700. It describes an electrically heated bath for tempering carbon steels.

CONDENSER-TUBE SHEET CLEANER—J. P. Flippen & Co., Pittsburgh, have issued a leaflet describing a cleaner which is installed in the side of the water-box and cleans the tubes while the condenser is in operation.

SEAMLESS FLEXIBLE METAL HOSE. Chas. Cory & Son, Inc., 185 Varick St., New York City, announce the distribution of the third edition of its hose Bulletin Nos. 201-29-C. This new 12-page catalog contains illustrations, data and descriptions of seamless flexible metal hose for use as a flexible conveyance of non-solids and non-abrasives, the principal feature being a seamless leakproof construction. The use of the hose is not limited to ordinary conditions, but includes applications for flexing and expansion at moderate and high pressures and temperatures and will, properly installed, remove destructive vibration. The bulletins are distributed gratis on request.

VERTICAL-TYPE ENGINES — Catalog No. 303 of Engberg's Electric & Mechanical Works, St. Joseph, Mich., describes a line of vertical, piston-valve steam engines of the inclosed type. Various features of design and several photographs of installations are shown.

VAPOR THERMOSTATS — The Klipfel Manufacturing Co., Chicago, Ill., has issued bulletin No. 127 describing a line of self-contained thermostats for automatic temperature control. The thermal element operates a bellows which controls a semi-balanced valve held open by a lever and weight or a spring. The bulletin includes a chart for determining the proper size thermostat valve for a given steam pipe.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Refractories Institute will hold its fall meeting Thursday, Sept. 15, at the Clifton Hotel, Niagara Falls, Canada.

American Water Works Association. California Section, at San Jose, Oct. 5-8; Paul E. Magerstadt, sec., East Bay Water Co., Oakland; Central States Section will hold annual meeting at Akron, Ohio, Sept. 15-16; E. E. Bankson, sec., Union Bank Building, Pittsburgh. North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Southwest Waterworks Association will meet at Hot Springs, Ark., Oct. 10; Lewis A. Quigley, sec., superintendent of City Waterworks, Fort Worth, Tex.

American Society of Mechanical Engineers. Calvin W. Rice, secretary, 33 West 39th St., New York City. Seattle, Wash. Section, Aug. 29-31.

American Welding Society, fall meeting at Book Cadillac Hotel, Detroit, Sept. 19-23.

Association of Edison Illuminating Co's, convention at Colorado Springs, Col.; Sept. 26-30.

Canadian Steel and Power Show and technical sessions will be held at the University of Toronto Arena, Toronto, Ont., Aug. 31, Sept. 1 and 2; Campbell Bradshaw, general chairman of exposition committees, 153 University Ave., Toronto, Ont.

Empire State Gas and Electric Association, meeting at Lake Placid, N. Y.; Oct. 6-7.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27, in connection with the Pacific Coast Power and Mechanical Exhibit.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held Oct. 10-13 at St. Louis, Mo.

SPRAY COOLING TOWERS—The Binks Spray Equipment Co., 3114 Carroll Ave., Chicago, has perfected a spray cooling tower especially adapted for the cooling of small quantities of water for Diesel engines, electrical transformers, small refrigeration plants and other applications where the quantity of water does not exceed 100 gal. per minute. Bulletin 5-E, covering this subject in detail, is now ready for distribution and is available upon request.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Aug. 10 1927
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.61
Clearfield	Boston	1.60@1.90
Somerset	Boston	1.70@2.00
Kanawha	Columbus	1.25@1.60
Hocking	Columbus	1.75@1.90
Pittsburgh	Pittsburgh	1.90@2.15
Pittsburgh gas slack	Pittsburgh	1.30@1.50
Franklin, Ill	Chicago	
Central, Ill	Chicago	
Ind. 4th Vein	Chicago	
West Ky	Louisville	2.25@2.50
S. E. Ky	Louisville	1.50@1.85
Big Seam	Birmingham	1.60@2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.50@4.25
Buckwheat No. 1.	Philadelphia	2.50@3.00
Birdseye	New York	1.60@1.85

FUEL OIL

New York—Aug. 18, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Aug. 10, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 4.4c. per gal.; 38@40 deg., 5.15c. per gal.

Pittsburgh—Aug. 9, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia—Aug. 16, 26@30 deg., $2.05@$2.11 per bbl.; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati—Aug. 15, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

Chicago—Aug. 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 22@26 deg., 85c. per bbl.; 26@30 deg., 90@92½c.; 30@32 deg., $1.00@$1.02½.

Boston—Aug. 8, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.3c. per gal.; 28@32 deg., 5.65c. per gal.

Dallas—Aug. 13, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

NEW PLANT CONSTRUCTION

Calif., Long Beach—Southern California Edison Co., 306 West 3rd St., Los Angeles, awarded contract for the construction of an electric generating plant on Terminal Island here to Stone & Webster, Laughlin Bldg., Los Angeles. Estimated cost $850,000.

Calif., Los Angeles—H. Rapf, c/o Walker & Eisen, Western Pacific Bldg., Archts., is having preliminary plans prepared for the construction of a 13 story apartment including steam heating and refrigeration systems, etc. at Irolo and Wilshire Blvd. Estimated cost $1,500,000.

Calif., Los Angeles—Rudolph Rosenberg, 5041 Franklin Ave., is having plans prepared for the construction of a 7 story machinery exchange building including steam heating system, etc. at 15th, Imperial and 16th Sts. and Santa Fe Ave. Estimated cost $1,500,000. Kernan & Miller, Bd. of Trade Bldg., are architects.

Calif., Los Angeles—University of California, will receive bids until Aug. 25 for the construction of a group of college buildings including boiler room, etc. at Westwood Campus. Estimated cost $150,000.

Calif., Oakland—Bercovich & Associates, c/o H. C. Baumann, 251 Kearny St., San Francisco, Archt., awarded contract for the construction of a 16 story apartment including steam heating and refrigeration systems, elevators, etc. on Grand Ave. to Thebo, Starr & Anderton, Sharon Bldg. Estimated cost $1,000,000.

Colo., La Junta—City voted $40,000 bonds for the construction of a sewage pumping station. G. E. Hine, is engineer.

Conn., Hartford—Travelers Insurance Co., 700 Main St., awarded contract for the construction of a 16 story office building on Central Row to Marc Eidlitz & Son Inc., 750 Main St. Estimated cost $2,500,000.

Conn., West Hartford (Hartford P.O.)—St. Thomas Seminary, M. F. McAuliffe, is receiving bids for the construction of a seminary including heating plant, etc. on Bloomfield Rd. Estimated cost $1,000,000. L. A. Walsh, 51 Leavenworth St., Waterbury, is architect.

Ill., Chicago—Huszagh & Hill, 6 North Michigan Ave., Archts., is receiving bids for the construction of a 17 story apartment building at Sheridan Rd. and Ardmore St. for E. Reid, 4753 Broadway. Estimated cost $1,000,000.

Ill., Chicago—Syndicate, c/o Huszagh & Hill, 6 North Michigan Ave., Archts., is having plans prepared for the construction of a 9 story hotel at Broadway and Sunnyside Ave. Estimated cost $1,000,000.

Ill., Chicago—Syndicate, c/o H. F. Knipp, 4802 Broadway, awarded contract for masonry, etc. for a 12 story apartment building at 3531 to 3551 Broadway. Estimated cost $1,115,000.

Kan., Hutchison—The United Power & Light Corp., of Kansas, plans extensions and improvements to power plant including 12,500 kw. turbo-generator with mechanical and electrical equipment, etc. McClellan & Junkersfeld, 68 Trinity Pl., New York, N. Y., are engineers.

Mass., Beverly—Commonwealth of Massachusetts, South Essex Sewage Bd., Fort Ave., Salem, will receive bids until Aug. 24 for the superstructure of Beverly pumping station, Water St. here. Private plans.

Mass., Norwood — Plimpton Press., awarded contract for the construction of a boiler house to W. Smith & Son.

Mich., Detroit—First National Co., First National Bank, awarded contract for the construction of a 19 story garage including steam heating and ventilation systems, boilers, elevators, etc. on Congress St. to Otto Misch Co., 159 East Columbia St.

Mich., Flint—Chevrolet Motor Co., will soon award contract for the construction of addition to factory including detached power plant. Wright & Nice, 4339 South Saginaw St., are architects.

Mo., Jefferson City—Missouri Power & Light Co., Kansas City, plans extensions and improvements to power plant including 3,000 kw. turbo generator, rebuilding of switchboard, etc. Estimated cost $250,000. Work will be done by day labor under the supervision of McClellan & Junkersfeld, 68 Trinity Pl., New York, N. Y., Engrs.

Mo., St. Louis—National Candy Co., 208 North Broadway, will receive bids about Aug. 25 for the construction of a factory including refrigeration plant, etc. at Gravois and Bingham Sts. Estimated cost $1,000,000. Klipstein & Rathman, 316 North Eighth St., are architects.

Neb., Wilber—City, A. J. Sherry, Clk, plans an election Sept. 6 to vote $35,000 bonds for the construction of a municipal light plant and distribution system.

N. J., South Orange—Sixty Two South Munn Ave. Inc., c/o H. F. Clark, 38 Clinton St., Newark, Archt., is having sketches made for the construction of a 10 story apartment including steam heating and refrigeration systems, boilers, elevators, etc. at 62 South Main St., here. Estimated cost $1,500,000. S. Shaw, 24 Commerce St., Newark, is engineer.

N. Y., New York—L. Adler, 38 West 32nd St., awarded contract for the construction of a 12 story U. S. appraisers stores at Hudson, Varick, West Houston and King Sts. to Shroder & Koppel Inc., 420 Lexington Ave. Estimated cost $6,000,000. Steam heating and ventilation systems, boilers, elevators, etc. will be installed. U. S. Government, is lessee.

N. Y., New York—A. E. Lefcourt, 1385 Broadway, will build a 25 story loft building including steam heating and ventilation systems, boilers, elevators, etc. at 7th Ave. from 25th to 26th Sts. Estimated cost $7,500,000. Buchman & Kahn, 49 West 45th St., are architects. Work will be done by separate contracts.

O., Cincinnati—J. G. Steinkamp & Bro., 1212 Mercantile Library, Archt., will receive bids until Sept. 7 for the construction of a 12 story office building at Central Parkway for American Druggists' Fire Insurance Co., 1004 Mercantile Library. Estimated cost $600,000.

Okla., Ada—City, L. Doggs, clk., will soon award contract for the construction of a new sewage disposal plant including two 1000 g.p.m. motor driven pumps, etc. Estimated cost $45,000. Black & Veatch, 700 Montreal Bldg., Kansas City, Mo., are engineers.

Okla., Enid—Banfield Bros. Packing Co., awarded contract for the construction of a packing plant including boiler room to Webb & Luther. Estimated cost $50,000.

Pa., Bethlehem—Central R.R. of New Jersey, Jersey City, N. J., will soon award contract for the construction of a power house here. A. E. Owen, is chief engineer.

S. C., Charleston—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will soon award contract for rewinding dry dock pump motors at Navy Yard, here.

Tex., Amarillo—Reagan County Purchasing Co., H. J. Corcoran, Pres., subsidiary of Marland Gas & Oil Co., Ponca City, Okla., is having surveys made for complete electrification of pumping equipment in oil fields at Edwards Plateau in Trans-Pecos fields. Estimated cost $250,000. Private plans.

Tex., Galveston—University of Texas, Austin, is having plans prepared for the construction of a power plant at John Sealy Hospital. Estimated cost $85,000. R. L. White, c/o owner, is architect.

Tex., San Antonio—San Antonio Public Service Co., c/o E. H. Kifer, San Antonio and Comal Power Co., New Braufels, will build a power sub-station on McCullough Ave., also two power distributing substations, one at Cementville St. on North Side and one on Babcock Rd. Estimated cost $75,000 and $50,000 respectively.

Tex., San Antonio—Smith Bros., c/o J. W. Young, Plaza Hotel, will soon receive bids for the construction of a 30 story office building including steam heating, refrigeration and ventilation systems, boilers, elevators etc. at St. Marys and Villita Sts. Estimated cost $2,000,000. A. B. & R. M. Ayres, 696 Bedell Bldg., are architects.

Wash., Seattle—Bd. of Public Works, will receive bids until Sept. 9 for the construction of Diablo dam on the Skagit River in connection with hydro-electric development.

Wis., Milwaukee—Dept. of Public Works, will receive bids until Sept. 8 for the construction of a 6 story public safety building including steam heating and ventilation systems, boilers, pumps, elevators, etc. at 8th, 9th, State and Cedar Sts. Estimated cost $1,200,000. A. R. Ross, 1 Park Ave., New York, N. Y., is architect. M. Cutler, 1019 36th St., Milwaukee, Wis., is engineer.

B. C., Beaver Cove—Canadian Forest Products Ltd., Vancouver Island, plans the construction of a power development, also pulp and paper plant on the Nimpkish River here. Estimated cost approximately $12,000,000.

Equipment Wanted

Air Compressor and Motor—A. B. Carley, Tipton, Okla., is in the market for a single stage air compressor and 20 hp. electric motor for waterworks.

Boilers, Etc.—A. Varaksin, Moskovsko-Kazanskaia Gel. Doroga, Elekticheskaia Stancia, Shatura, U. S. S. Russia, prices and catalogs on boilers, (a) P = 20 at abs., t = 375 deg. C. surface 1,000, 1,500 and 2,000 sq. meter, (b) p = 25 at abs., t = 400 deg. C., surface 1,000, 1,500 and 2,000 sq. meter, (c) p = 35 at abs., t = 400 deg. C., surface 1,000, 1,500 and 2,000 sq. meter, forced and induced draft for boilers, air preheaters for boilers t. deg. preheated air 250 to 270 deg., piping for steam and water for equipment for power plant.

Cold Storage Plant Equipment—Silverwoods Cargill Creamery, W. McNab, mgr., Cargill, Ont., wants prices and catalogs on equipment for cold storage plant.

Compressor Unit—Empire Pipe Line Co., Bartlesville, Okla. will be in the market for a 1000 hp. gas compressor unit for proposed natural gas compressor station at Tallant, Okla. Estimated cost $40,000.

Power Plant and Boiler House Equipment—Ajax Rubber Co., Racine, Wis., will soon purchase equipment for power plant and boiler house to increase the capacity.

Power Plant and Boiler House Equipment—The Sessions Engineering Co., 228 North La Salle St., Chicago, Ill., is preparing equipment specifications for the new power plant and boiler house of the Fort Howard Paper Co. at Green Bay, Wis.

Pump—M. G. Comar, 424 Hickox Bldg., Cleveland, O., is in the market for a deep well electric pump.

Pump and Motor—J. W. Collier, Tipton, Okla., is in the market for a 100 g.p.m. triplex pump and 15 hp. electric motor for waterworks.

Pump and Motor—City of Bristow, Okla., is in the market for a 150 g.p.m. deep well pump and motor for proposed waterworks improvements.

Pumps—Bd. of Trustees, of Springfield Sanitary Dist., G. T. Cresse, pres., Springfield, Ill., will receive bids until Sept. 13 for sludge pumps, etc. for proposed sewage treatment plant.

Pumps—City of Wewoka, Okla., will be in the market for three motor driven centrifugal pumps for proposed waterworks improvements. Estimated cost $125,000.

Pumps—Dept. of City Transit, Philadelphia, Pa., will receive bids until Aug. 30 for electrically operated sump pumps for drainage sumps at Broad St. subway.

Pumps—Mayor and Bd. of Aldermen, Goldsboro, N. C., will receive bids until Aug. 25 for two dual drive centrifugal pumps complete with starting and control equipment for proposed waterworks improvements.

Steam heating system—Dept. of Public Works, Milwaukee, Wis., will receive bids until Aug. 24 for furnishing and installing a vacuum steam heating system for boiler house at North Point pumping station. Estimated cost $6,300.

Transformers, etc.—Bd. of Purchase, H. C. Cain, Secy., City Hall, Columbus, O., will receive bids until Sept. 1 for one 50 kva., four 100 kva. and four 75 kva. transformers, 60 cycle, 2300 v., 230 r.p.m., also one 1300 ft. No. 4 Standard 4 conductor lead covered cable.